DESIGN AND CONSTRUCTION OF ACROW PANEL BRIDGES IN NORTHERN MANITOBA

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ABSTRACT

The East Side Road Authority (ESRA) is committed to improving access to Manitoba's remote First Nation communities. As a part of this overall vision, a series of bridges were proposed to be constructed at key locations on the existing winter road system in the Island Lake region. These bridges have been situated at the Red Sucker River, Mainland River and Stevenson River. The construction of bridges over these rivers is expected to extend the surrounding winter road use by up to 2.5 months. Additionally, the project provided a significant employment opportunity and training for local residents of the various First Nation communities through a strong working relationship with the ESRA.

Due to the access and construction equipment limitations associated with these construction sites, Acrow Panel Bridge systems were utilized. A single 61 m clear span was utilized for the Red Sucker and Stevenson River bridges. The Mainland River Bridge has three spans with a total length of 85 m and a clear span of 61 m across the river. Construction of the three bridges commenced in January 2012 and is expected to be completed and opened to traffic for the winter road season of 2014.

This paper describes the many challenges associated with designing and constructing bridges in remote Northern Manitoba locations. Some of the major challenges included working in environmentally sensitive areas, limited access to additional equipment and materials, and poor subgrade soils limiting site mobility.

1. INTRODUCTION

2.1 East Side Transportation Initiative

The area east of Lake Winnipeg is home to approximately 36,000 residents who live in remote and isolated communities that are accessible only by air or winter roads. The Government of Manitoba established the East Side Transportation Initiative to improve the transportation for the residents of these communities.[1] The 30 year vision of the East Side Road Initiative is to connect these communities to the provinces all weather road network by constructing roads and bridges covering 1,028 kilometres, with an estimated cost of approximately $3 billion.[2] The goal of the project is to reduce the cost of living, improve emergency, health, education and social services for the residents living on the east side of Lake Winnipeg. The construction of an all-weather road will also provide opportunities for further development in industries such as forestry, mining, hydro, fisheries, and tourism[3].

ESRA's mandate also includes providing the residents on the East Side of Lake Winnipeg with construction employment opportunities through a number of Community Benefits Agreements. These agreements can be from right-of-way clearing and grubbing, to producing granular materials for the all weather road construction, to road and bridge construction. ESRA has also implemented a number of training courses to fulfill their mandate to increase the economic opportunities for each of the communities.

2. PROJECT BACKGROUND

As a part of the overall initiative the Province of Manitoba/ESRA made a commitment in January 2011 to construct three temporary bridges along the winter road network in the Island Lake region between the communities of Red Sucker Lake First Nation and Norway House First Nation. These bridges are located at key locations on the winter road network to increase the reliability of the winter road. Traditionally the ice crossings at Red Sucker Lake, Bigstone Lake and Pelican Rapids either delay the construction of the winter road by restricting access to various segments of the winter road or are the last segments of the network to be completed each year. The winter road network is usually open to traffic near the end of January and is typically in operation until mid to late March.[3] This provides the communities in the Island Lake region approximately eight weeks to transport the majority of the goods and supplies by truck into their communities. For the remainder of the year, air is the only means to transport goods and supplies to the communities, which significantly increases the cost of living in this area. The three bridges are also intended to improve the constructability of the eventual east/west all-weather road that is planned from the Red Sucker Lake First Nation to Norway House. This segment of all-weather road represents approximately 400 km's of the overall 1,028 km initiative.

Norway House is the west limit of the east-west winter road link connecting to the communities of St. Theresa Point, Wasagamack, and Garden Hill, approximately 225 km to the east. The winter road then continues on approximately 135 km's east to the community of Red Sucker near the Manitoba/Ontario border. The Pelican Rapids Bridge, commonly referred to as Feather Rapids, on the Stevenson River is approximately 140 km's east of Norway House and 100 km's west of Wasagamack.

The Bigstone Lake Bridge is approximately 40 km's west of Wasagamack. The Red Sucker Bridge is approximately 10 km's west of the Red Sucker Lake First Nation. It should be noted that Figure 1 is presenting the preferred all weather road network option which is not necessarily the same location as the existing winter road.

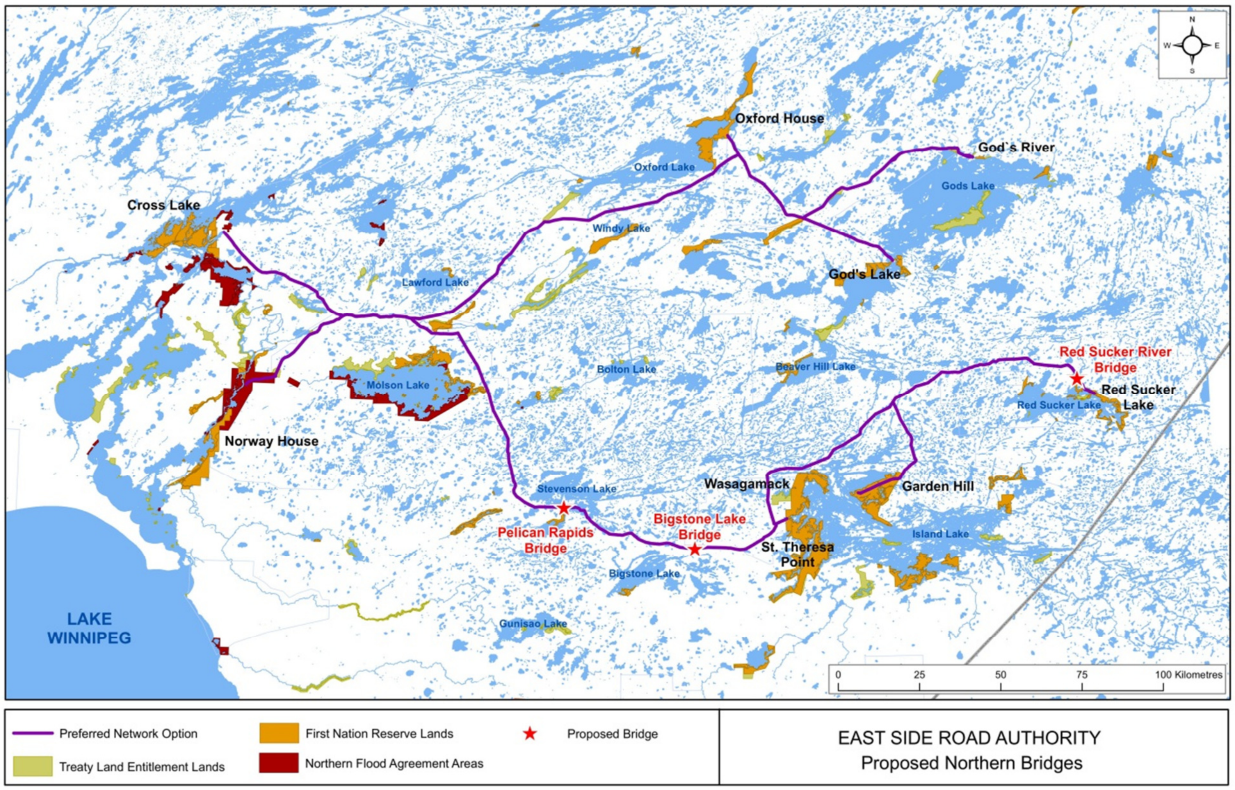

Figure 1: Proposed Bridge Locations

This paper describes the challenges of designing and constructing bridges in remote locations in northern Manitoba. For clarity throughout the paper, the bridges will be referred to as Mainland, Red Sucker, and Feather Rapids.

3. DESIGN

3.1 Site Investigation

The site investigation consisted of travelling to each of the proposed sites by helicopter. This provided the opportunity to obtain an aerial view of the river in close proximity to the existing winter roads to identify potential crossing locations. Considerations in locating suitable bridge sites included:

1. Proximity to existing winter road network,
2. Width of the river with preference given to locations where a temporary Acrow bridge could clear span the river, and
3. Input from the local first nations residents or their representatives.

In order to clear span the Mainland River, a location approximately 1 km from the winter road lake crossing was proposed for the new bridge location. Due to the profile of the riverbanks at this location, a three span bridge was proposed with the main span clear spanning the river. The proposed location for the Pelican Rapids crossing was approximately 300 m upstream of a pre-existing winter road crossing over the Stevenson Lake. A bridge constructed with timber cribbing had been installed by the Red Sucker Lake First Nation many years ago at the mouth of the Red Sucker River. Over time this bridge had deteriorated and become unusable for vehicle or pedestrian use. The new crossing location over the Red Sucker River was approximately 100 m downstream of the existing bridge.

Figure 2: Mainland River Bridge Location

Figure 3: Red Sucker River Bridge Location

Figure 4: Feather Rapids Bridge Location

3.2 Geotechnical Investigation

Due to the lack of drill rig availability during the 2011 winter road season and construction planning to start during the 2012 winter road season, the drilling program occurred during July and August 2012. The remoteness of the three bridge sites required the drill rig to be transported by both plane and helicopter. One challenge that was overcome during the drilling program was to ensure that each of the airports had equipment that was suitable to load the drill rig into the plane as well as unload the drill rig from the plane. The drill rig used for this project was a ACKER SSII portable drill rig equipped with 125 mm diameter solid stem augers and HQ rock core barrel. The drill rig was transported from the airport to site via a Astar 305 B2 helicopter. Other helicopters considered for the drilling program included the Bell 206B Jet ranger and the Bell 205 A1. Although the Astar 350B2 helicopter did not have the highest capacity for hauling equipment, it was the most economical helicopter for transporting both the drill rig and personnel to the sites. The drill was transported to the site and assembled at the test hole location. Following the drilling of each test hole the drill was disassembled into approximately five components and transported to the next test hole where it was reassembled. Relocation of the drill rig required eight to nine return helicopter trips to transport the 12,600 lb drill rig, equipment, and personnel. The drilling at the three bridge sites was completed in 14 days between July 24 and August 8, 2011.

Local community members assisted in the drilling program through providing wildlife protection at each of the bridge sites. Clearing and grubbing for helicopter and drill rig landing pads were also completed by local residents at each test hole location.

Figure 5: Drill Rig Assembly at Mainland River

Figure 6: Drill Rig Assembly at Red Sucker

3.3 Foundation Design

This bridge foundation was designed in accordance with the AASHTO – LRFD Bridge Design Specifications 5th Edition, 2010. Standard Manitoba Infrastructure and Transportation design truck loadings considered were Modified AASHTO MSS 22.5 (HSS25) Design Truck Loading, and AASHTO LRFD "HL-93" Truck and Lane Loadings. Based on the anticipated vehicular traffic and availability of Acrow panel parts, the bridge superstructures were designed in accordance with CSA S6-06 Canadian Highway Bridge Design Code with a CL-625 Design Vehicle.

The initial conceptual design for the foundation at the Mainland River site included two concrete abutments and two concrete piers founded on driven steel H piles to bedrock. However, the geotechnical investigation concluded that the sub surface soils above the bedrock were incapable of resisting the horizontal forces that would be applied to the bridge. Further, sloughing of the surficial soils was also noticed during the geotechnical investigation which did not permit for any excavation near the river. This added another level of complexity relating to the constructability of the foundations. Therefore, the Mainland River Bridge foundation design consisted of 12" steel pipe piles that were installed into the bedrock. The piles are grouted into the bedrock and a reinforced concrete cap is constructed to transfer the loads from the superstructure to the steel piles to complete the two pile bents and two abutments.

At the Red Sucker site, bedrock was encountered at approximately 4.5 m and 1.8 m below the surface at the east and west abutments respectively. Due to the relatively shallow depth to bedrock, the foundation design consisted of a concrete spread footing anchored to the bedrock with a concrete pedestal.

The Feather Rapids geotechnical investigation revealed that bedrock was approximately 4.5 m below the surface at both the east and west abutments. Bin wall abutments consisting of galvanized steel boxes filled with free draining granular material and capped with a concrete bearing pad were initially chosen during the conceptual design. Concrete spread footings were not considered as the abutments were situated close to the water's edge. With the soil profile above the bedrock very similar to the Mainland River site, constructability regarding the excavation dewatering and installation of the bin wall was a major concern. Following consultation with ESRA and the Contractor during the contract negotiation it was decided that the foundations for the Feather Rapids Bridge be changed to steel pipe piles with reinforced concrete pile caps to improve constructability and reduce the environmental impacts.

3.4 Superstructure Design

The preferred superstructure alternative was the ACROW 700XS steel truss (Acrow). The Acrow superstructure was selected due to the long clear span lengths and that it could be launched into place resulting in no in water works. Although the Acrow superstructures have a deep cross section, this superstructure has a relatively low structure depth below the top of the bridge deck of approximately 900 mm. The main advantage to the ACROW trusses is the fact that the trusses are constructed of modular steel components that are shipped by truck to the site, and do not require any specialized shipping vehicles or trailers, which is ideal for the limited accessibility of the bridge locations along the winter road system. The trusses are then assembled on the approach embankment by bolting the components together and the bridge is then launched into place. The ACROW bridge also includes a timber deck curb and steel W-beam guardrail that are all connected to the trusses. The assembly and installation of the bridge and deck aligns with ESRA's overall vision to provide opportunities for training local labourers and economic development.

Figure 7: Timber Deck Assembly at Red Sucker

3.5 Roadway Design

The roadway design followed Manitoba Infrastructure and Transportation (MIT) standards for winter roads. This included a 20 metre wide clearing for portions of the winter road providing two six metre wide lanes with four metre wide shoulders for snow berms that are created in constructing the winter road. For the granular approach roadways embankments, an 8.1 metre top width was provided. Although the approach roadways were constructed for two lanes, the limited traffic volumes permitted a reduced bridge width of 4.775 (curb to curb), which does not permit vehicles passing on the bridge but provides significant cost savings for both the substructure and superstructure construction. The approach roadways were designed to MIT and Transportation Association of Canada (TAC) standards with a 50 km/hr design speed. One approach, located on the south side of the Mainland River bridge, necessitated the use of lower speeds due to the limited room available at the bridge crossing location.

The roadway geometry was also designed to permit a WB-20 design vehicle to maneuver through any of the curves on the approach roadway embankments leading up to the bridge. The approach roadway embankment structure was designed according to the MIT standard with 500 mm of 150 mm crushed granular material which was topped with 150 mm of 19 mm crushed granular material.

4. CONSTRUCTION

Construction for the three bridges started at the Mainland River in January 2012, Red Sucker River in June 2012, and Feather Rapids in January 2013. The projects were structured by ESRA as Community Benefits Agreements (CBA) with the First Nation in which the bridge was located. The purpose of the community benefits agreement is to provide a direct benefit to the FN community by providing jobs, training and mentoring related to construction and maintenance, and other long-lasting economic development opportunities. For the Mainland and Feather Rapids bridges, Wasagamack First Nation's (WFN) construction company Mehkana Development Corporation (Mehkana) was the prime contractor. For the Red Sucker bridge, Red Sucker Lake First Nation's (RSLFN) construction company 6173536 Manitoba Limited was the prime contractor.

Due to the long working relationship between the First Nations and Arnason Industries Limited (Arnason), both Mehkana and 6173536 utilized Arnason as a sub-contractor for the construction of the bridges. For the Red Sucker bridge, 6173536 entered into a Joint Venture Agreement (JVA) with Arnason, whereas for the Mainland and Feather Rapids bridges, Mehkana maintained the relationship of prime-sub-contractor. The labour force at each bridge site comprised of over 75% aboriginal workers, of which included approximately 30% of the workers from the First Nation community in which the bridge was being constructed at.

To date, the Red Sucker bridge and approach roadways have been completed. The Mainland and Feather Rapids bridges and approach roadworks are scheduled to be complete in September 2013. Final clean up, site restoration works, and demobilization from all three sites is scheduled to occur in February 2014. The following sections will discuss the construction of the bridges as well as the challenges that were encountered.

4.1 Site Preparation

Prior to the start of construction, site preparation and equipment mobilization began in February 2011 at all three sites in preparation of the bridge and roadway construction. The typical soil conditions at the sites consisted of silty sand and bedrock outcrops, overlain with peat and organic material. The poor soil conditions made the construction of the laydown and temporary site roads especially challenging. For example, at the Mainland River bridge site, the contractor spent two months removing the peat layers, draining the site, and creating access roads.

Figure 5: Typical Soil Conditions at Mainland

Figure 6: Archaeological Investigation at Mainland

During the design stages, archaeological investigations were completed at the three sites and concentrated in areas where bridge and roadway construction would disturb the existing ground. At the Red Sucker and Feather Rapids bridges, no artifacts were encountered. However at the Mainland River bridge site, multiple artifacts were discovered and during construction a complete archaeological investigation and recovery program was instated to ensure all artifacts were retrieved from the disturbed areas of the site.

Bulk fuel tanks and site camps were also installed at each of the three sites to facilitate the bridge and road works occurring throughout the year. As noted previously, the winter road is open for only a few weeks each year, so all equipment, fuel and camps were organized and planned a full year in advance to make sure that construction could proceed smoothly without interruptions or shutdowns.

As the sites were all in close proximity to local trappers from the First Nation communities, coordination was required prior to construction to have site meetings and discuss the upcoming works. The laydown and construction areas were noted and the environmental management of the sites was highlighted in detail. Moose hunting frequently occurred in these areas as well, so it was necessary to coordinate a clear zone during construction for the safety of all workers on site.

4.2 Substructure

The substructure for the Mainland and Feather Rapids bridges were reinforced concrete (RC) abutments and piers supported on steel pipe piles. The substructure for Red Sucker was RC abutments seated directly on the bedrock. Both support systems provided many challenges throughout construction.

Due to the relative simplicity of the Acrow assembly and launching procedures, construction of the substructure required the most effort and time to complete. Consequently the construction challenges and issues were also primarily associated with substructure.

4.2.1 Mainland

Specialized drilling equipment for the installation of the steel pipe piles into the underlying bedrock was transported to the site immediately following the January 20, 2012 opening of the winter road. As it would be prohibitively costly to leave the equipment on site for the entire year, it was necessary for multiple drilling rigs to be mobilized to complete the drilling. The drilling operations were maintained 24 hours a day for both drill rigs, which necessitated around the clock geotechnical inspection. Due to unseasonably warm weather and rainfall, the winter roads were closed less than four weeks earlier on March 13, 2012. Despite the additional efforts employed for the drilling works, it was not possible to complete the piling in the shortened winter road season.

Figure 7: Drill Rigs at Mainland

Figure 8: Concrete Placement at Mainland

Fortunately over half of the piles were completed and the south abutment and pier were able to be constructed throughout the summer of 2012. Due to lessons learned from the 2012 winter road season, road improvements and advanced snow packing and flooding on the lake crossings were completed by January 2013. These efforts were a major contributing factor in the winter road opening ahead of schedule. On February 5, 2013 drilling operations resumed with the completion of the north abutment and pier pile installation completed before the end of the month. The construction of the remaining substructure was completed immediately after piling finished allowing the concrete batching equipment to be transferred to the Feather Rapids site for concrete production on that site.

The area surrounding the substructure units was excavated to the necessary grades, which exposed the highly erosive silty sand material. As the erosion control was of utmost importance, rigorous planning was required to ensure that the substructure construction and subsequent damp-proofing and backfilling were completed in time for the erosion control to be installed prior to the 2013 spring thaw and runoff.

4.2.2 Red Sucker

As the Red Sucker bridge was seated on the existing bedrock, it was not necessary to complete the substructure works during the winter road season as no drilling for piles was required. The excavation and construction of the substructure commenced in August 2012. The substructure work could have commenced in the previous months, however the high water conditions around the river prevented any excavation work from being completed around the abutments. The high water conditions caused overland flooding which encompassed the boulder fields beside the river. With the overland flooding, this area was deemed to be fish spawning habitat and the in-water works were delayed to the end of the fish spawning season on July 15. Even after July 15, the overland flooding was too extensive to commence excavation so in the following weeks a proactive solution was required to limit the delay of construction and maintain the opening date of January 2013 in time for the winter road season.

The Red Sucker River is the only outlet for the Red Sucker Lake and with the high water conditions in the lake; it was unlikely the river was going to recede to within its regular channel. Compounding this issue is an existing timber bridge, which was installed by the RSLFN, approximately 150m upstream of the bridge location. The timber bridge acted as a weir and backed up water and facilitated further overland flooding.

While the overland flooding primarily occurred within a 20m band of the boulder field to the west of the river, it was possible to identify channels of water within the flooding area. It was determined these channels could be intercepted approximately 15m north of the west abutment and be rerouted back to the primary river channel. On August 11, 2012 the channel re-routing was completed protecting the west abutment area from overland flooding. To mitigate the loss of fish habitat developed due to the overland flooding and control the sediment released during construction, an extensive protection and recovery program was instated for the construction of the west diversion channel. This included the use of turbidity monitoring and fish salvages.

Figure 9: Turbidly Monitoring at Red Sucker

Figure 10: Fish Salvage at Red Sucker

After the channel diversion had been installed and the overland flooding was addressed, the excavation for the substructures commenced. Ground seepage was a constant issue and despite the installation of clay plugs to limit seepage, several submersible pumps were utilized to maintain a dry excavation. As there was significant laydown area available around the abutments and the excavation depths were less than 5m, open-cut excavation was utilized, although shallow slopes were required due to the seepage issues.

Figure 11: Channel Re-Route at Red Sucker

Figure 12: ChannelRe-Route at Red Sucker

Upon initial excavation, it was not evident what the elevation of the bedrock was as there were many large boulders overlying the bedrock. After the bedrock was exposed the entire face was cleaned of all mud and debris to facilitate a full geotechnical inspection to verify the capacity of the bedrock.

The bedrock elevation within the footprint of the substructure was highly variable and required a leveling RC working slab to provide a level surface for the abutment footing. The working slab was constructed with full strength concrete and was reinforced throughout the surface of the bedrock and along the edges of the working slab. The working slab varied in thickness between 0.1m and 1.7m over the foot print of the footing. This highly irregular surface necessitated custom reinforcing to limit areas of concrete without reinforcing and adequate development of bedrock capacity. Once the working slabs were installed, the RC footings and abutment seats (backwall) were constructed.

4.2.3 Feather Rapids

Similar to the bridge at Mainland, the foundation design consisted of pipe piles drilled into the underlying bedrock. Significant consideration was given to scheduling during the winter road season to ensure the piling works could be completed at the Mainland site in time to facilitate the installation of the piles at Feather Rapids before the winter road closed. With the extensive coordination efforts between the client, contractor, and Dillon, the drilling was completed at the Mainland site in February 2012, and the drill rigs were brought to Feather Rapids with pile installation completed in March 2012.

Due to the rapid pace of pile installation, the lessons learned from the other bridges, and cooler than average temperatures, the concrete works for the substructure was completed by April 2013. This reduced the environmental management efforts required to prepare for the spring thaw and runoff.

4.3 Superstructure

As discussed above, the superstructure for the three bridges was an Acrow panel bridge system. This Acrow system consists of assembling pre-fabricated steel panels which act as the girders, together with transoms which act as diaphragms and supports for the stingers which provide support for the timber decking. A portion of the Acrow parts were transported to the site during the initial mobilization of equipment in 2011, and when the design for the bridges was finalized, an additional shipment of parts had to be sent to site to accommodate the finalized span lengths.

Figure 13: Acrow Construction at Red Sucker

Figure 14: Acrow Construction at Red Sucker

In general, Acrow panel bridges are typically assembled and launched into place. This consists of assembling the bridge on rollers and then incrementally pushing the bridge across the river to the foundation on the other side of the river. A pre-cambered launching nose is attached to the front of the bridge to account for the deflection that occurs in the bridge during launching. The detailed sequence of the assembly and launching as follows:

- Following the backfill of the abutments, the launching and receiving pads behind the abutments were constructed using either crushed blast rock or granular material.
- The part lists are verified on site and the parts are organized in piles that are readily accessible.
- Cast in place concrete blocks are installed on the launching side at a spacing of 7.6m and align directly below where the vertical panels will sit. After the elevation of the concrete blocks has been achieved through grinding or shimming, the rollers are installed on each of the blocks and assembly can commence. A set of rollers is also installed on the receiving abutment and this is where the launching assembly will touch down when the bridge is pushed across the river. While the assembly and launching of the Acrow panel system is relatively simple, it is imperative the initial layout of the rollers is accurate horizontally to ensure the launch will reach the rollers on the side and vertically to limit the differential stresses in the parts. To achieve smooth rolling and assembly as well as directional launching, a tolerance of no more than 5mm was instated for both horizontal and vertical layout.

- Assembly was completed with a crane and loader on the launching side and an excavator on the receiving side. A diligent process of steel assembly and torqueing operations must be observed to ensure the bridge is not assembled too far in advance of bolt tightening and verification.
- Launching of the bridge occurred simultaneously with the assembly. As the bridge gains sufficient length and the center of gravity is shifted away from the leading roller, which is located at the launching abutment, the bridge is pushed forward and begins to cantilever out towards the receiving abutment. Once the bridge is fully constructed, additional counterweight is installed on the back of the bridge to offset the weight of the launching nose and shift the center of gravity further back and allow the nose to touch down on the receiving abutment. After the bridge is received on the far abutment, the launching nose is removed and the bridge is jacked up to remove the rollers at the abutments, and then jacked down to its final location on the bearing plates.
- Once the bridge is fastened to the abutment via welding the bearings to the base plates, the installation of the stringers and timber decking is completed. The side curbs and guardrails are also installed. A timber backwall is installed on top of the abutment, behind the bridge, and provides a retention mechanism for the roadway structure.

Throughout the assembly of the bridges, safety was the number one priority. There were frequent tool-box talks and these occurred whenever the activities were adjusted or a new task was instated. The contractor also organized an on-site fall protection training course to solidify the commitment to safety. During the presentation of the course, the training company also installed the fall protection system. All personnel wore fall protection and maintained the overall sense of "safety first" on site. Dillon and Acrow personnel were actively involved in enhancing the safety program on site due to the extensive experience in these tasks.

Throughout the design process and construction of the substructure and roadways, Dillon has developed strong working relationships with 6173536 and Arnason and this was instrumental in the successful assembly and launching of the Red Sucker bridge. With strong teamwork, this complex coordination effort was completed at a rapid pace and of high quality. We are anticipating the Acrow bridge assembly and launching will occur in a similar manner at Mainland and Feather Rapids with Mehkana and Arnason and occur in July and August 2013.

4.4 Roadways

Generally, site preparation and construction of access roads was completed at the same time as the removal of overlying organic layer for the roadways. After the organic layers was removed, common excavation was completed which utilized either in-situ materials or granular material to fill to the sub-grade elevations. The installation of the crushed granular for the roadway structure occurred in phases with the launching of the bridge. Typically the 150mm crushed granular was installed prior to bridge construction, except on the launching and receiving pads, as the elevations had already been set for bridge assembly. After the bridge was launched, the embankment construction was completed and the remaining roadway structure was installed. However, each site had challenges that arose during roadway construction.

4.4.1 Mainland

Several key considerations were factored in selecting the suitable bridge and roadway location for each site. The selection of the Mainland bridge was approximately 1 km from the winter road lake crossing, which was selected for ideal span lengths and crossing location. However, north of the north abutment there was a large bedrock outcrop. Blasting was required to meet the necessary roadway grades and width requirements. The blasted granite shot rock was hauled to an area northwest of the project site, at a clearing along the winter road alignment. In the clearing, a crushing spread was set up to crush the blast rock and provide the 150mm sub-base and 19mm base course, as well as the class 350 rip-rap. Due to the capacity of the crushing spread, it was difficult to produce the rip-rap, and to compensate the contractor mobilized a skeleton bucket which sorted the unprocessed blast rock into the necessary gradation. Although the sorting process was cumbersome, the jagged blast rock provided ideal rip-rap material with maximum erosion control capacity.

Figure 16: Blasting Area During Excavation at Mainland

Figure 17: Crushed Rock Produced at Mainland

4.4.2 Red Sucker

The Red Sucker roadways were originally designed to be completed after the bridge was assembled and launched to take advantage of the large excavation volumes on the east side. However, during bridge construction, it was determined that considerable schedule acceleration could occur if a borrow source could be found on the west side. As there is an open quarry approximately 1 km to the west of the site, the roadway was filled to sub-grade elevations with unprocessed granular material (pit run). A large crushing spread was set up at the quarry and the crushed granular and rip-rap was also sourced from this quarry.

Figure 18: Crushed Rock from Quarry at Red Sucker

Figure 19: Road Upgrades at Red Sucker

On the east side, it was noted in discussion with MIT, that swamps and low lying areas typically produce the highest quality sections of the winter road as they tend to be relatively flat with few boulders and protruding hills. As the roadway was designed to extend into the swamp, Dillon recommended a reduction in length with the cost savings put towards enhancing the roadway conditions further away from the bridge site. This was accomplished through the removal of small hills and boulders, both of which provided a much higher quality winter roadway. Also the reduction in length in road also facilitated an increase in approach grade which provided cost savings to offset the sourcing of the borrow material on the west side.

The approach roadway on the west side was originally designed to fall within the existing clearing limits to minimize impact to the site, which necessitated a very tight turning radius. After discussion with MIT, and RSLFN it was determined that the safety enhancements at this location from decreasing the approach angle would justify some additional clearing. The roadway design was altered and the road was constructed providing longer sight lines and accommodated higher approach speeds, with an overall increase in roadway safety at the west approach.

4.4.3 Feather Rapids

At Feather Rapids, the roadway construction preceded the bridge work to take advantage of the time prior to the drill rigs completing the pipe pile installation at the Mainland site and mobilizing to the Feather Rapids site. Some minor blasting was required on the west side and due to the extreme environmental sensitivity of this site, labeled as rare fish habitat and a major spawning ground, extreme care was required to ensure the blasting did not exceed the DFO guidelines for the use of explosives near fisheries waters.

Blasting was also completed in a rocky outcropping further away from the river as blast rock was required for laydown areas and access roadways. As the outcropping (quarry) area was sufficiently far away from the river, a much larger blast was possible.

Figure 20: Blasting at the Quarry at Feather Rapids

Figure 21: Sewn Geosynthetic at Feather Rapids

On the east side of the bridge, a large swamp is present only 70m away from the abutment. During the winter, this swamp will provide ideal winter road conditions. However during the summer, there were concerns that the roadway could potentially fall apart from below unless an extensive segregation layer was provided. By providing a heavy duty geosynthetic layer, sewn at the edges for a continuous piece along the entire width, the degradation concerns were addressed. Due to the use of a heavy duty geosynthetic, specialized sewing facilities had to be sourced and were eventually completed in Georgia, USA.

During the design and negotiation phase of the CBA, it was decided that it would be less expensive to crush additional blast rock for the roadway granular material at the Mainland site and haul it to Feather Rapids. A convoy of trucks was organized and over the course of February 2013, the contractor hauled all the required roadway granular material to the Feather Rapids site.

5. LOGISTICS

Coordinating the movement of personnel, supplies, and equipment provided as much challenge as any aspect of the bridge and roadway construction due to the remoteness of the sites and lack of roadway access for 10 months of the year. Even when the winter road was open, the winter road conditions limit the speed to 40-60 km/hr. The closest airport to Mainland and Feather Rapids is located at St. Theresa Point. While flights to site typically were less than 20 minutes to Mainland and 35 minutes to Feather Rapids, driving times were significantly longer and generally took around 2.5 hours and 3.5 hours to travel from St. Theresa Point. to Mainland and Feather Rapids respectively.

At Red Sucker, the community is approximately 10 km from the site and is surrounded by the Red Sucker Lake. During the summer it was possible to utilize a high weight capacity boat to transport personnel, materials and smaller equipment to site. Mainland and Feather Rapids did not have this option and transportation was through the use of helicopters and float planes which had limited weight capacity which often required additional time and effort to transport critical camp and construction materials and personnel to site.

The primary method of transporting large equipment and materials was through semi-trailers during the winter road season. This necessitated extensive planning and scheduling efforts as well as long hours for site personnel to offload, to limit turn-around time. The contractors noted that during winter road construction they typically run 21 hours a day with split shifts, just to get everything moved in time.

While getting to site was itself very challenging, the greatest complication at each site was how to bring personnel, equipment, materials and fuel across the river to complete the work on both sides. A barge system was installed at the Mainland site. However due to the lower than anticipated river water levels, the barge was unable to transport any equipment heavier than a ½ ton truck due to the concern of the barge coming in contact with the riverbed and causing silt disturbance in the waterway. After it was deemed the barge was unusable due to environmental concerns, the equipment on the north side was no longer able to obtain fuel and the contractor had to organize regular trips with a freight helicopter to bring drums of fuel to the equipment on the north side.

With the overland flooding issue at Red Sucker a temporary bridge was required to maintain the completion date in time for the 2013 winter road season. The girders and timber were flown to the RSLFN airport via a Hawker Siddeley HS 748 turboprop airliner and then transported to site with the high weight capacity fiberglass boat. Despite the 3000 lb capacity of the boat, each girder was transported individually and took several days of dedicated effort. The temporary bridge was installed and was used throughout the project to get personnel, small equipment, fuel and materials from the camp side to the far side.

Based on the success of the temporary bridge at the Red Sucker site, Dillon recommended that a temporary bridge be installed at Feather Rapids to take advantage of the simplicity of movement. Also at the Feather Rapids site, as it had been deemed extremely environmental sensitive for fish habitat, no equipment crossing would be permitted even though there is a fording location that is easily traversable during the summer. Construction of the temporary bridge at Feather Rapids was also complicated as it required additional clearing near an area that the local trapper uses for fishing and hunting. A meeting was held between the WFN Chief, the trapper, Dillon and the contractor and an agreement was reached that allowed minor additional clearing to facilitate temporary bridge construction in exchange for the restoration of the navigation channel in the river where the fording location had been previously installed.

Overall the logistics effort was complicated and required significant coordination, but by working together with the contractor and First Nations, we were able to get the personnel, supplies, and equipment to where they needed to be and developed strong working relationships between all parties in the process.

6. TRAINING

Various training opportunities have been provided throughout the project at the bridge sites, this includes ESRA providing direct training and mentoring of First Nation workers with the goal of undertaking future construction projects. ESRA worked with the local First Nations personnel to prepare the required Monthly Health and Safety (H&S) and environmental documentation during construction. Other training opportunities included a two day, on site fall protection and rescue course. The training was completed by all workers prior to bridge construction activities.

7. REFERENCES

1. Province of Manitoba website http://www.gov.mb.ca/chc/press/top/2011/01/2011-01-14-133500-10660.html

2. http://www.canadianconsultingengineer.com/news/manitoba-starts-3-billion-permanent-road-network/1000937581/

3. http://www.eastsideroadauthority.mb.ca/vision_transportation.html

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