Bridge-Plate Corrugated Structural Plate

OWNERS
County of Dufferin, ON

CONTRACTORS
Nelson Arnold Construction
R.J. Burnside and Associates

CONSULTANTS

LOCATION
Dufferin County Road 124 at Noisy River

Through the creative application of existing products and construction techniques, Armtec provided a practical, cost-effective solution for replacing a distressed bridge on a heavily travelled highway. The Bridge-Plate soil-steel structure was constructed over a four-month period despite limited on-site space, severe environmental limitations relating to the river, and the need to keep the road open at all times.

TECHNICAL DETAILS

• 9 metre-span, half round-Bridge-Plate Arch
• HP570 high-strength woven Geotextile
Background:
In the 1950s, the Ontario Department of Highways reconstructed the conventional concrete bridge at Highway 24 and the Noisy River with a 6.2m wide x 3m high x 36m long, open bottom cast-in-place concrete culvert on concrete footings. By the time the County of Dufferin assumed responsibility of this heavily travelled portion of the highway in 1998 (renaming it Dufferin County Road 124), the culvert was distressed and required rehabilitation.

In 2000, the south footing failed because of a lack of bearing capacity below the footing, creating a public safety hazard. The structure was designated for immediate replacement, and a series of braces were temporarily installed inside the culvert to prevent a catastrophe.

The County of Dufferin retained R.J. Burnside and Associates as the consulting engineers for this project. A soil-steel structure was selected for the replacement bridge, based on cost and construction staging compared to alternative solutions.

Design:
The site conditions at the Noisy River project presented several construction challenges. Dufferin County Engineer Stuart Smart, P.Eng., explained: “Because the Noisy River was a well-known trout stream, the river could not be temporarily diverted, nor could it be contaminated with debris. County Road 124 could not be closed to traffic at any time during construction because of the heavy truck traffic and the lack of practical, alternative routes. In addition, the site was very tight, and any solution had to fit inside our property boundaries.” This meant that one-lane, signalled detours were required, and construction would take place in two phases.

Armtec was consulted on the optimal soil-steel structure for this application. To aid in the construction of the detours, Armtec also proposed the construction of two temporary retaining walls made of high-strength woven geotextile. A 5.5m high wall was to be used to construct the first detour, while the eastern half of the replacement structure was installed. For the bridge itself, Armtec proposed a 9m span, half round Bridge-Plate arch on new concrete footings. The Bridge-Plate structure had a rise of 4.5m with a granular cover of 1.83m at the shoulders, and a plate thickness of 5.0mm.

“Given the physical and budgetary constraints of this project, the combination of the Armtec Bridge-Plate structure and the geotextile-reinforced retaining walls provided the best overall solution to the traffic and construction staging issues presented by the Noisy River site.”

Steven Riley, P.Eng, Project Manager R.J. Burnside

First half-structure assembled. Traffic diverted over a temporary geowall. Notice the box in the middle.
Construction:
Stage 1 of the project commenced in early September 2000. Once the signal lights for the detours were in place, work began on the excavation of the west end of the failing structure and construction of the first temporary wall. The 5.5m wall was constructed beside and above the failing structure to safely provide for one lane of traffic within a half-length of the structure. Once this detour was completed, alternating one-way traffic was diverted to the western half of the bridge.

After the east half of the structure was excavated, demolition of the cast-in-place box commenced. The contractor first placed a series of wide flange beams across the river, with the ends resting on the existing footing. Steel sheeting was placed on the beam ends to form a solid barrier and prevent concrete rubble from entering the river.

In both stages of construction, the footing of the concrete box was left in place and all construction took place outside of the old bridge.

For the Bridge-Plate structure, each portion of the steel erection took place in two stages. The structure contained 30 rings, comprised of five plates each. The erector first sub-assembled the three top plates into top arcs. Next, they placed the side plates on either side, and then added the top arc assemblies. Each individual ring was fully erected prior to starting the next ring. Once all the plates were in place, the bolts for the entire half-structure were torqued to specification.

Backfilling of the structure started with construction of the second temporary wall at the mid-point of the bridge. This wall was built in the same manner as the first wall, using OPSS Granular A (required for the Bridge-Plate) and HP570 geotextile.

Backfill was placed and compacted in 200 ml lifts to 95% Proctor Dry Density. The other end of this half-length structure formed the downstream embankment. End treatment consisted of small headwalls on either side of the structure with the embankment sloping at 2:1 above the headwalls.

Once the backfill and temporary wall were complete, the roadway was paved to complete the second detour.

During Stage 2, traffic was diverted to the new detour. Stage 2 construction was similar to that of the first stage. At the splice point of the two bridge halves, the backfill for Stage 2 was compacted up against the fabric wall. Due to its flexible nature, this wall could simply be buried in the backfill without affecting the bridge structure in any way. Dufferin County Road 124 was restored to two-lane traffic in early December 2000.