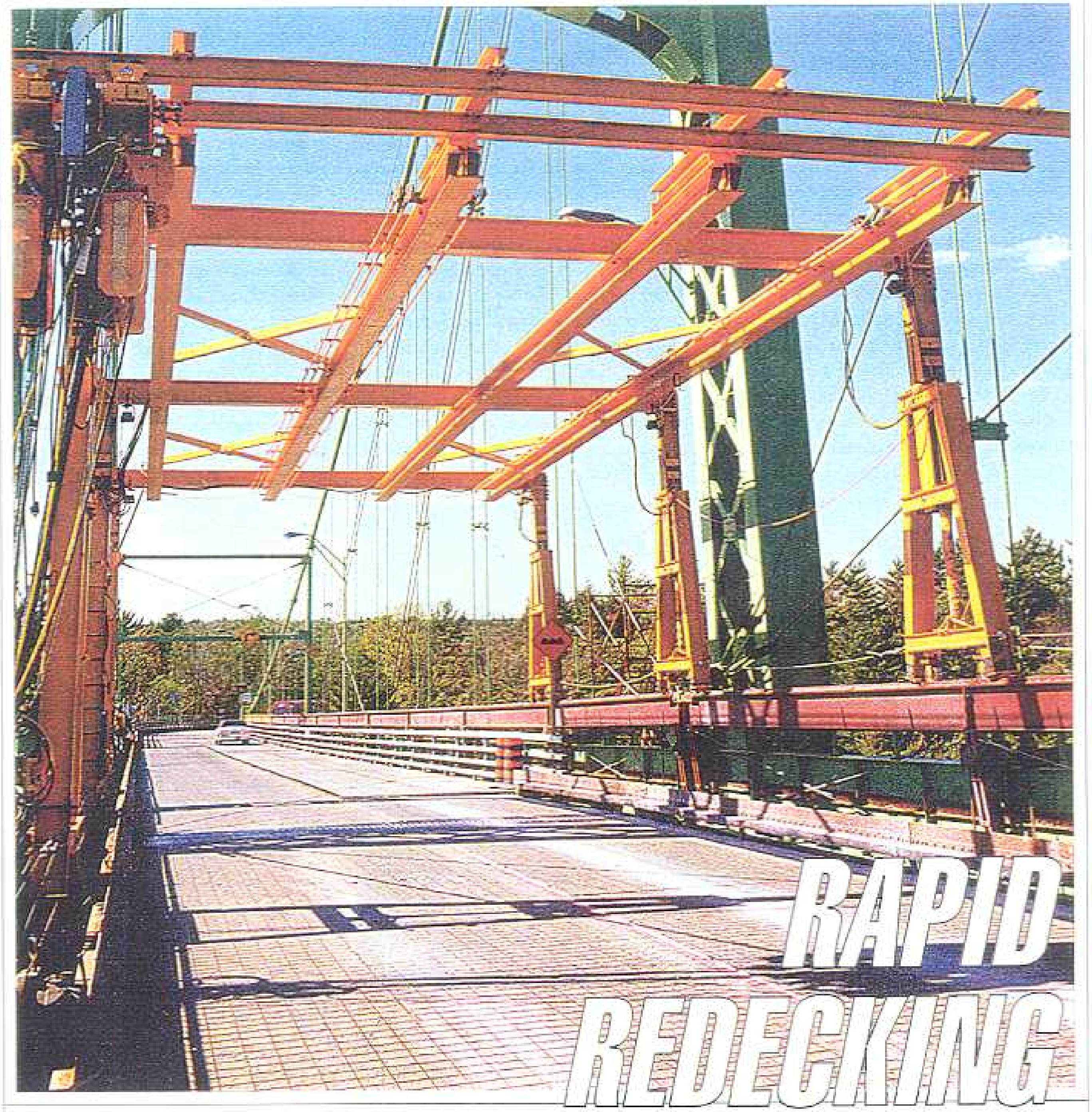

# RAPID REDECKING

*Round-the-clock schedules helped an extensive bridge deck replacement project finish a year ahead of schedule despite limited lane closure requirements.*

RANDY PICKLE, P.E.

A contractor replaced nearly 7,000 $m^2$ of steel grid roadway deck filled with microsilica concrete on the Canadian part of the Thousand Islands bridge system more than one year ahead of the contracted completion date and more than a month ahead of the contractor's own schedule.

The Thousand Islands are actually 1,082 islands, some as small as a few square meters, located in the St. Lawrence River immediately downstream of Lake Ontario. A series of spans over the American and Canadian portions of the river, which meet on Hill Island, make up the Thousand Islands bridge system. The bridges link Highway 401, a major expressway from Windsor, Ontario, to the city of Quebec and Interstate 81 in New York State. Annual traffic volume exceeds 2 million vehicles, with an average of 1,000 trucks and 4,000 cars each day.

A 1994 study showed that decking on the Canadian crossing needed replacement. Capital projects funding for the Thousand Islands bridge system relies on

**IN DAYTIME TRAFFIC FLOWED UNIMPEDED UNDER A PORTAL FRAME GANTRY USED IN THE EVENING TO LOWER NEW CONCRETE-FILLED STEEL GRID DECK PANELS INTO PLACE.**

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vehicle tolls, so closing the Canadian crossing during construction was not an option. Construction was expected to last about two years. It began early in 1997, and all work was to be completed by November 1998. The contract permitted only nightly closures of one lane for deck replacement, and travel delays caused by construction were expected to reduce traffic, and therefore toll revenue.

In 1995, Steinman, Boynton, Gronquist and Birdsall, New York, and Delcan Corp., Toronto, prepared construction drawings and specifications for rehabilitation of the Canadian crossing. The St. Lawrence Seaway Authority awarded the $14 million deck replacement contract to Peter Kiewit Sons Construction Limited, Mississauga, Ontario, which submitted a construction schedule proposing completion of all work by the end of 1997.

The Canadian crossing comprises four bridges that span the river's north channel. The signature span is a 412-m-long suspension bridge rising more than 36 m above the river from the Canadian mainland to Georgina Island. A 106-m-long rib arch bridge connects Georgina Island to Constance Island, and a 183-m-long Warren truss leads from Constance Island to Hill Island, leading to the border and the American crossing. Viaducts form the north and south approaches to the Canadian crossing and span the islands between the suspension, arch and truss bridges. Built in 16 months and completed in 1938, the Canadian crossing has a total length of 1,014 m.

Full crews worked the day and night shifts to help complete the project ahead of schedule. For example, day crews installed new stringers before night crews removed the old ones during deck replacement, saving time and simplifying lane closure arrangements. The contractor selected galvanized stringers, clip angles, bolt assemblies and other associated structural steel elements. In addition to reducing long-term maintenance costs, the galvanized elements eliminated the need to apply two coats of epoxy paint on-site and reduced painting from a major to a minor task.

WORK PLATFORM SECTIONS WEIGHING 60 METRIC TONS EACH WERE FLOATED ON POLYSTYRENE, PULLED BY TUGBOAT BENEATH THE OVER-WATER SPANS (ABOVE) AND THEN LIFTED INTO PLACE (BELOW).

The work proposed for the suspension and for the Warren truss span was similar, and included replacing the four-stringer floor system with five stringers to accommodate the widened deck. The viaduct and arch spans presented different conditions, including crossbeam extensions, longer and heavier deck panels, removal and replacement of concrete diaphragms, and a greater number of welded shear studs.

The 1994 structural inspection showed that the substructure and all abutments and piers were in good condition, but the suspension and Warren truss spans were not. The truss span deck was cracked and separated from the stringers and some floor beams had warped. In addition, the concrete deck surface had spalled and cupped. Suspended span decking showed similar distress and wear. The inspection concluded that the decking was nearing the end of its service life, and total replacement was recommended by the year 2000. Viaduct and arch span decking, despite being in good condition, also was recommended for replacement to provide a continuous deck width for the crossing.

## WIDER IS BETTER

A limited rehabilitation effort in 1991 included deck replacement on the north approach. To better accommodate truck traffic, the deck was widened from 6.7 to 7.3 m by removing the sidewalk on the east side of the end spans. This work continued with the full-scale rehabilitation in 1997.

The new steel grid deck panels are filled with high-performance microsilica concrete. On the suspension and truss spans, the top of the 10-metric-ton steel grid deck panels is the driving surface. The viaduct and arch span panels, with a 50 mm overfill of air-entrained concrete over the steel grid, weigh 21 metric tons each. The additional thickness accommodates lower deck supports and maintains a continuous roadway elevation.

To lift out the old panels and lower the new ones into place, workers used a movable portal frame gantry system that rested on the structure during deck replacement. The frames spanned the roadway without reducing vertical or horizontal clearances on the structure. Rail guides provided lateral restrictions to the gantry wheels, ensuring the gantry moved parallel to the direction of the deck replacement.

Hydraulic rams capable of raising and lowering the frame supported the gantry's cross frame and made it possible to lift the deck panels vertically rather than in a plane perpendicular to the bridge deck. This reduced additional forces on the gantry. Three portal frame assemblies erected on the rails formed a 15-m-long gantry, the minimum required to remove one 7.6 m panel at a time and transfer it to a flatbed.

The original schedule called for replacing, on average, one to one and a half deck panels per night. The 102 suspension span panels were completed in 62 days, an average installation rate of nearly 1.65 panels per night.

Portal struts between the trusses prevented the portal frame gantry from providing the minimum vertical clearance for trucks on the Warren truss. An overhead gantry system built for that span consisted of I-beam rails erected beyond the limits of the new roadway all along the truss with a hoist frame attached to the bottom flange of the rails.

The end geometry of the truss members made certain deck sections at both ends unreachable by either gantry system. For these areas, the contractor employed a rubber-tire-mounted crane resting on deck panels on the adjacent, completed viaduct spans, ensuring the 50-metric-ton-capacity crane was supported by new construction. Crews carried out a complete replacement of the Warren truss deck 17 days ahead of schedule.

To minimize point loading on the viaduct structures, Kiewit set up the crane with the outriggers fully extended on mats spanning several crossbeams. The bridge had to be closed while old deck sections were lifted onto flatbed trucks for removal and new deck panels were placed.

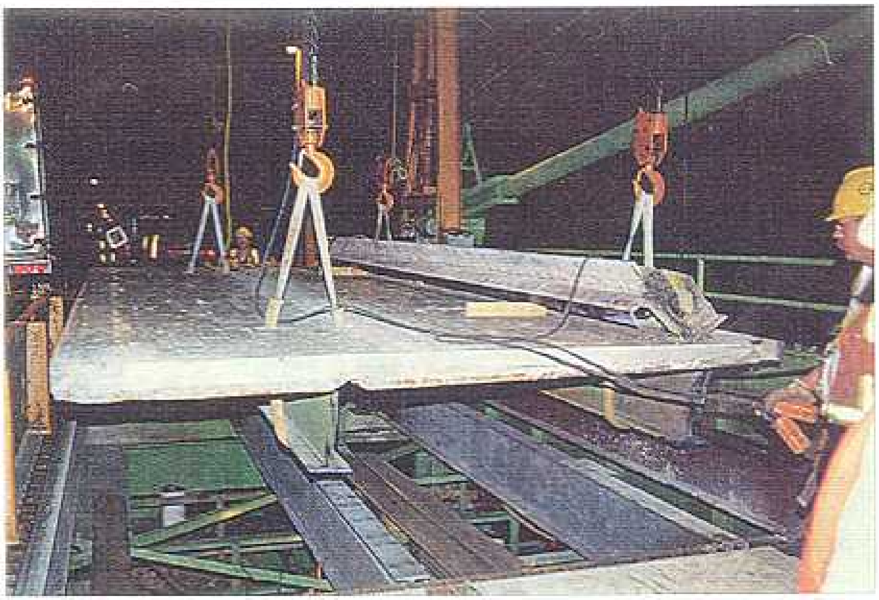
For stringer replacement between the floor beams of the suspension spans and, subsequently, the truss spans, the contractor designed a work platform system suspended below the structure and supported from the top flange of the east and west stiffening girders. The platform's flooring was made of plywood with open grate inserts to minimize wind resistance.

## Tugboats and Styrofoam

Installing work platform sections under the main span over the St. Lawrence River presented fabrication and erection problems. The 60-metric-ton sections, built at a small site just downstream of the bridge, were placed on polystyrene blocks, pulled into position under the center span by a tugboat and hoisted into place.

To monitor the effects of construction loads, consulting engineers Totten Sims Hubicki Associates Ltd., Whitby, Ontario, the contract administrator, regularly surveyed floor beam elevations during installation of the work platform. The final survey, taken when all sections were raised and secured to the stiffening girders, indicated that the imposed loading deflected the deck 390 mm downward near the main center span at the southern limit of the work platforms. The corresponding deflection in the north end span was approximately 50 mm upward.

Work platforms remained in position throughout stringer installation and deck replacement operations within the span. A new work zone under the center span required moving the platforms south by means of hoists and traveler rails. Tower loading remained balanced until four platform sections were moved to the south side of the midspan, which required counterbalancing. Precast concrete Jersey barriers temporarily placed on the south span were gradually replaced with work platform sections to



NIGHT CREWS WERE ABLE TO REPLACE 102 SUSPENSION SPAN DECK PANELS IN JUST 62 DAYS, BEATING CONSTRUCTION SCHEDULE REQUIREMENTS WHILE KEEPING BOTH LANES OPEN DURING THE DAY.

TRUSS MEMBERS PREVENTED CONTINUATION OF A MAINTENANCE WALKWAY ALONG THE SPAN'S EAST SIDE, AND FORCED USE OF AN OVERHEAD GANTRY SYSTEM TO MEET TRUCK CLEARANCE LIMITS. A RUBBER-TIRE-MOUNTED CRANE HANDLED DECK SECTIONS UNREACHABLE BY EITHER GANTRY SYSTEM.

balance the loading within the work zone.

When the time came for complete removal of the platform sections from the suspension span, the contractor reversed the installation process, alternating from span to span and dropping platform sections evenly from both sides of the tower. The contractor duplicated the stringer operations on the Warren truss, again using the polystyrene block system to transport platform sections to spans over water.

Girders and crossbeams hindered work platform installation below the deck on the viaduct and arch spans. The spans' location over islands also prevented access for platform delivery and for equipment to raise the sections. The contractor designed a cantilevered work platform with joists extending from the crossbeams. Workers installed the platform by first working over the edge of the existing deck, and then from the newly installed sections to extend the platform along the span.

Increasing the deck width on all spans required changes to the walkways of the Canadian crossing. The east-side walkway was narrowed and converted to a maintenance platform running the length of the crossing with the exception of the truss span, where the members made erection of the 51-mm-deep open galvanized grid impossible. The west-side walkway, originally a combination of supported grid panels and reinforced-concrete slabs, was removed and replaced with 51-mm-deep concrete-filled steel grid panels with a 40 mm overfill. The new walkway, extending along the entire west side of the crossing, is—depending on the span—supported by the stiffening girders, handrail posts or the outside edges of the new deck panels. Workers also installed a four-rail barrier on both sides to protect pedestrians and maintenance workers from vehicle traffic. Prior to rehabilitation, a curb was all that separated the walkways from the roadway.

**Widening the deck forced alterations to the suspension and truss span deck supports.**

Widening the deck also forced alterations to the suspension and truss span deck supports, where floor beams span the deck laterally between either the stiffening girders of the suspension spans or the members of the truss. The beams, located every 7.62 m, were originally connected by four stringers spaced 2.13 m apart between the extremes of the deck panels. Widening the deck and moving the east edge while leaving the west edge in its original location moved the roadway's centerline east. This required a five-stringer system, with one stringer at the new roadway centerline and the rest spaced at 1.905 m intervals.

Originally scheduled for completion in 72 working days, stringer installation and associated structural work on the suspension bridge took only 62 days, a rate of more than five stringers per day.

On the viaduct and arch spans, lateral crossbeams support the roadway deck. The beams bear on stiffening girders along the east and west sides of the structures. The crossbeams were long enough to support the wider deck panels but not long enough to maintain a west-side walkway and an east-side work platform. Workers added extensions to the existing crossbeam using splice plates. The contractor scheduled 148 days to install the extensions and replace the viaduct and arch span decking, but crews completed the work in 105 working days, almost 30% faster than planned. ▼

*Randy Pickle, P.E., M.ASCE, is an engineer at Totten Sims Hubicki Associates Ltd., Whitby, Ontario.*