Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 73/1/73/2 (1995)

Artikel: Rehabilitation of the Gardiner Expressway, Toronto, Canada
Autor: Li, Edward K. / Woodman, Carl W.
DOI: https://doi.org/10.5169/seals-55166

Nutzungsbedingungen
Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. Mehr erfahren

Conditions d'utilisation
L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. En savoir plus

Terms of use
The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. Find out more

Download PDF: 09.12.2025

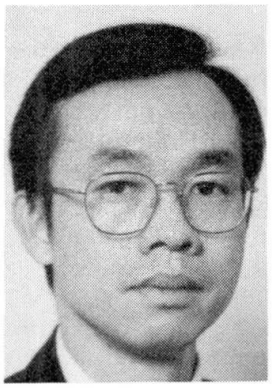
ETH-Bibliothek Zürich, E-Periodica, https://www.e-periodica.ch

Rehabilitation of the Gardiner Expressway, Toronto, Canada

Réparation de l'autoroute Gardiner à Toronto, Canada

Instandstellung des Gardiner Expressway, Toronto, Canada

Edward K. LI
Assistant Manager
Morrison Hershfield Ltd
Toronto, ON, Canada



Edward Li, born in 1953, obtained his degree at the University of Hong Kong in 1976. He joined Morrison Hershfield in 1989 and is responsible for designing and managing bridge projects for the firm, including the F.G. Gardiner Expressway Rehabilitation Project.

Carl W. WOODMAN
Assist. Dir. of Engineering
Municipality of Metropolitan Toronto
Toronto, ON, Canada

Carl Woodman, born in 1945, received his civil engineering degree from the Technical University of Nova Scotia in 1968. He joined METRO Transportation in 1969, and has been responsible for many of the F.G. Gardiner Expressway maintenance and rehabilitation projects.

SUMMARY

The Gardiner Expressway is the major link to the downtown financial district of Toronto, Canada. After 16 years of service, the 8 km elevated structure of the Expressway already required considerable structural repairs. As the condition of the structure continued to deteriorate, major work was required to extend the life of the structure. This paper describes the strategic planning of the rehabilitation programme and the adoption of a repair method that involved a significant alteration of the original structure.

RÉSUMÉ

L'autoroute Gardiner est la liaison principale du centre ville de Toronto. Après 16 ans d'utilisation, les 8 kilomètres de la voie surélevée ont nécessité de nombreuses réparations. L'état de la structure continuant à se détériorer, il a fallu entreprendre des travaux considérables pour prolonger la vie de cette autoroute. Ce document explique les moyens stratégiques utilisés dans le programme de reconstruction et l'adoption des modalités pour les réparations requises. Les moyens utilisés impliquent des modifications importantes à la structure actuelle.

ZUSAMMENFASSUNG

Der Gardiner Expressway ist eine Hauptverkehrsader zum Finanzzentrum in der Innenstadt von Toronto, Kanada. Die 8 km lange Hochstrasse wurde bereits nach 16 Betriebsjahren reparaturbedürftig. Kostspielige Reparaturen wurden daraufhin ausgeführt, jedoch der Zustand verschlechterte sich weiterhin. Dieser Bericht beschreibt die strategische Planung für das Sanierungsprogramm und die Anwendung einer Reparaturmethode, die eine bedeutende Umänderung der ursprünglichen Baustruktur erfordert.

1. INTRODUCTION

1.1 The F.G. Gardiner Expressway in Toronto located on the north shore of Lake Ontario was built in the early sixties. Figure 1 shows a bird's eye view of the elevated portion of the Expressway. The most prominent feature of the 14 km long Expressway is an 8 km elevated roadway, composing of mainly simply supported spans resting on concrete bents. A 6.2 km length of this elevated roadway carrying a major portion of the traffic became the centre of the subsequent rehabilitation study. The main deck of this section was made up of 507 spans with a total deck area of 240,000 square metres. These spans were principally concrete slabs on steel I-girders (79%), concrete overlay on prestressed concrete box girders (16%), or in-situ concrete slab and beams (5%). An expansion joint was generally located at every supporting bent.

1.2 The ineffectiveness of the waterproofing membrane and leaking joints did not provide adequate protection against de-icing salt attack. This resulted in the rapid deterioration of concrete and steel members. Corrosion of steel reinforcement led to severe cracking and concrete delamination, which in time turned into extensive spalling. Falling concrete fragments became safety concerns to drivers, pedestrians and adjacent properties. Additionally, the deteriorating condition of concrete and steel components was substantially reducing the capacities of the structural members.

1.3 Beginning in 1972 the Transportation Department carried out various maintenance efforts to repair and prevent further damage caused by salt corrosion. These efforts included expansion joint replacement, asphalt resurfacing, concrete patching and shotcreting. However, it was recognized that continuation of maintenance activities only was insufficient to address the increasing deterioration problems. In 1984, the 1 km section of the elevated roadway on concrete box girders, which showed the worst signs of deterioration, was repaired. Details of the repair can be found in [1]. It was then realized that a long term repair strategy was required.

2. THE MAJOR INVESTIGATION AND THE STRATEGIC PLAN

2.1 To develop the strategic plan, an investigation was carried out in 1985 [2]. The purpose of the investigation was to determine the condition of the structure, to formulate the technical solutions to the problems, and to estimate the quantities of work involved in the rehabilitation. A representative section of the elevated roadway utilizing deck-on-steel-girders was selected for surveying. The investigation took three months to complete, encompassing extensive visual inspections, corrosion potential measurements, sawn asphalt samples, coring and chloride content tests.

2.2 The Strategic Plan for the rehabilitation of the elevated section of the Expressway was prepared and approved by Metropolitan Toronto Council in 1986. The study, considering the previous work undertaken and the experience gained, developed a long-range rehabilitation program, to maximize the life of the structure and to minimize the future maintenance cost of the Expressway [3]. Recommendations of the Strategic Plan included:

1. A strategy by which consecutive events should follow with cost estimates for a period of 40 years;

2. A 20-year Construction Programme within which the main roadway deck would be repaired in 9 years; and

3. A principle of operation, which established the priority of rehabilitating the deck as the first activity.

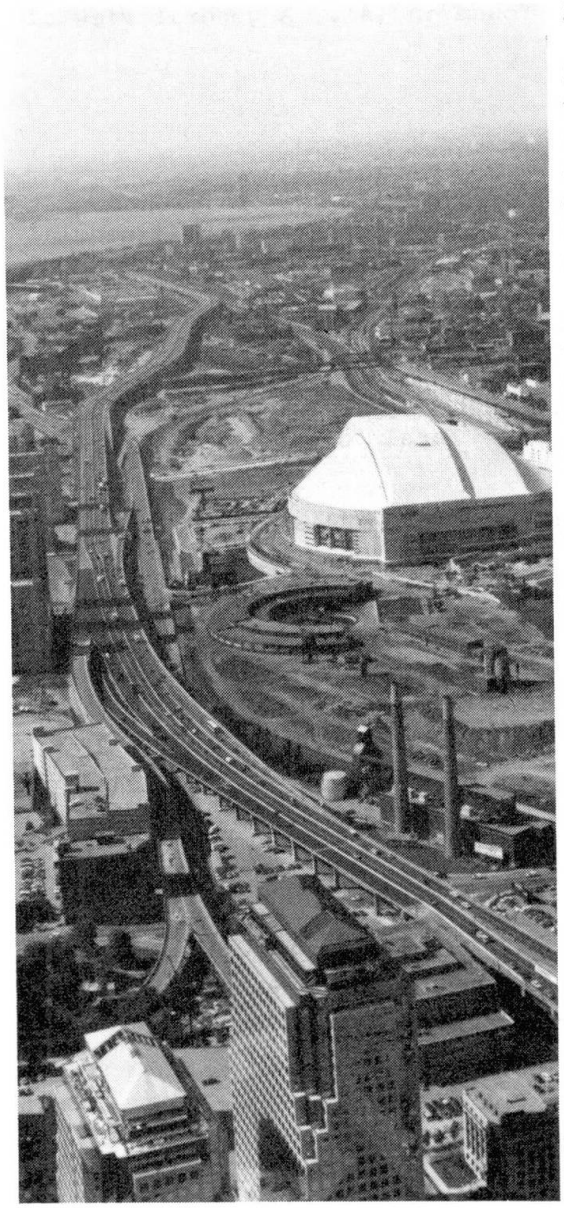


Figure 1
The F.G. Gardiner Expressway
Toronto, Ontario, Canada

3. DESIGN

3.1 The design was to produce a watertight deck to protect the substructure from further salt damage. In addition, after repairing all of the existing defects, the deck had to provide a service life of at least 15 years before further rehabilitation would be required.

3.2 To accomplish this, it was decided to minimize the number of existing joints . The longitudinal joint between the twin bridges was replaced with a concrete slab and additional cross-frames, essentially tying the 2 bridges together. Three out of four existing expansion joints were eliminated by making the deck continuous for a number of spans. The tying of originally simply supported spans required complete revamping of the bridge articulation system, by providing new bearings and expansion joints. Thermal movements of the tied deck were accommodated by flexing of the supporting bents, while ensuring that the existing fixed bearings would be strong enough to withstand such movements. The tying method chosen was called the "flexible link", which consisted of a thin and highly reinforced concrete slab. This link allowed the connecting spans to continue to behave as simply supported spans, with the end rotations due to traffic loading being accommodated by the flexing action of the link. A more detail description of the link slab can be found in [4]. Such re-arrangement of structural layout in rehabilitation projects was the first designed and built in Canada. All remaining expansion joints were replaced with joints incorporating readily replaceable seals with steel armouring.

3.3 An innovative "flood-free" drainage system was devised. The system utilized a fibre-glass hopper mounted on either the girders or the supporting bents. The hopper collected silt and allowed sediment-free water to enter the main drainage network. The inlet was designed to discharge water as quickly as possible and to accommodate a "vacall" type hose for the periodic removal of silt. At those times when the hopper was filled with silt, water could still drain off the deck by overflowing at the hopper.

3.4 The rehabilitation also involved

1. Repairing damaged deck and parapet areas, by patching and refacing;
2. Incorporating a new bituminous waterproofing layer and asphalt surface;
3. Reconditioning bearings to re-activate their movement capabilities.

3.5 Some of the above design details can be found in [4]. A general view of the repair scheme is shown in Figure 2.

4. TRAFFIC MANAGEMENT

4.1 The Expressway is a major East-West link across the City of Toronto. It also serves the centre of activities of this busy city, including the financial district and the SkyDome, one of the most popular sports complex in North America. Every contract had to be well planned to ensure the least disruption to the public. The mandate of these plans was to keep at least two out of the three existing traffic lanes open in each direction at all times, and to:

1. Ensure safety for drivers by providing adequate signing, sight distances, pavement markings etc. according to the local construction traffic guidelines;
2. Co-ordinate with other construction work to minimize impact;
3. Ensure sufficient structural capacity during any working stage, and provide adequate spaces for the lapping of reinforcement, waterproofing and asphalt;
4. Build additional working and detouring space for next contract by repairing areas beyond original limits of contracts;
5. Obtain approvals from various authorities, and carry out test drills for emergency conditions that could occur within the site;
6. Hold liaison meetings to keep all involved parties informed of developments, necessary closures, etc.; and
7. Publish pamphlets, notify media and, through telephone hot-lines, advise the public of the work, possible delays and recommended detours.

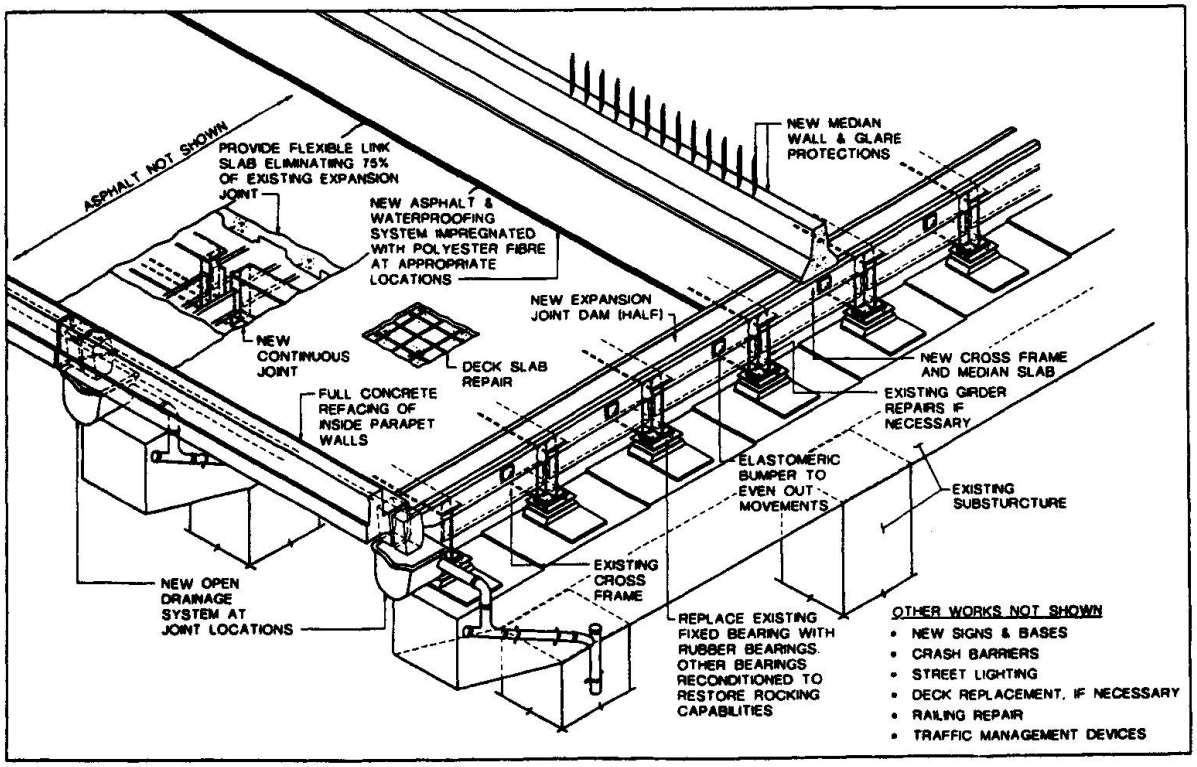


Figure 2 - General Deck Rehabilitation Scheme

5. CONSTRUCTION

5.1 In 1986, a pilot contract was tendered to gain experience and refine the details of the main innovations. From 1987 to 1995, the 1986 rehabilitation techniques were used to tender one major deck repair contract every year, for a total of 9 contracts. The annual expenditure and the approximate cost of repair per square metre of the deck are shown in Table 1.

TABLE 1

Year	Contract Sum	Deck Area Repaired	Cost / Sq.M.
1987	C$ 5,450,000	35,700 sq.m.	C$ 153
1988	C$ 5,900,000	25,600 sq.m.	C$ 230
1989	C$ 6,900,000	23,100 sq.m.	C$ 299
1990	C$ 6,542,000	21,900 sq.m.	C$ 299
1991	C$ 5,555,000	19,600 sq.m.	C$ 283
1992	C$ 5,493,000+	18,300 sq.m.	C$ 300
1993	C$ 5,159,000*	9,300 sq.m.	C$ 554
1994	C$ 1,850,000**	7,700 sq.m.	C$ 240

+ plus C$ 0.8M for substructure repairs * includes C$ 4.7M for deck replacement work
**an additional C$ 0.4M was spent on substructure repairs

5.2 Construction began with rehabilitation of bearings by rust removal, new coatings, and bearing replacements. Repairing the bearings required slight jacking of all girders connected by cross-frames, and the erection of access platforms to carry out the work. Tying of the twin bridges together using additional cross frames was also carried out in this stage.

5.3 On the deck, stage 1 of the traffic detour was implemented. Work zones, which normally started within the median area, were delineated by concrete barriers, with appropriate signage and markings. Asphalt was stripped exposing concrete deck for sounding and repair. After removing the required deck areas, construction of new continuous deck (the flexible link slab), the expansion joint dams and the median slab were cast, with all necessary splicing details in place. At the same time, delaminated areas were removed and patched. On completion of all concrete and steel repairs, new waterproofing and the first layer of asphalt were then laid. The work was then switched to Stage 2 of traffic detour, and executed in the similar sequence. At this stage working was confined to the curb lanes where the joints were reconstructed along with the replacement of existing drains. Additionally, the inside face of the existing parapet walls were rehabilitated and surface-sealed. Stage 3 of the detour, involving work on the opposite curb lane of the bridge, followed and was executed in a similar fashion. Lastly, in Stage 4, the median lanes were re-occupied for the construction of median barrier walls and glare protections.

5.4 On a pre-arranged closure, the concrete barrier walls, for construction safety, were removed, the seals for the expansion joints were installed in complete pieces and the entire surface asphalt was laid in one operation. Traffic markings, lighting and electronic traffic management devices were installed / activated and the full width of the elevated roadway was opened to traffic. Under-deck work such as drains and pipes continued until final completion.

5.5 Some of the unanticipated new problems arose in the course of the rehabilitation program were:

1. Rubber membranes, normally sandwiched in the waterproofing to provide tensile strength where movement in the deck was expected, deformed. It was found that upon overlaying with hot waterproofing, the rubber deformed and wrinkled (known as the "braining" phenomenon), causing severe cracking in the asphalt pavement. The rubber membrane was subsequently replaced by polyester fibre sheets.

2. In many situations, the deterioration of the concrete bents required specific seating details for the jacking of girders. These problems were normally overcome by constructing additional steelworks attached to the existing columns for the jacking operation. At low bents and at abutments, jacking was sometimes done against kentledges laid on the ground.

3. The major ramps connecting the F.G. Gardiner Expressway with another expressway required complete deck replacement. A condition survey, carried out prior to tendering determined that up to 70% of the deck was delaminated, as well as on major portions of the parapet wall. Traffic was diverted to a single lane in each direction on one of the connecting ramps while the other was reconstructed. In addition other traffic had to be detoured through adjacent streets. While this rehabilitation provided a challenging and costly traffic diversion scheme, it afforded an opportunity to widen the connecting ramps and improve sight distances. The widening also provided additional space for disabled vehicles. The deck replacement is expected to have a life of at least 50 years.

6. CONCLUSION

6.1 By fall 1995 the main deck of the Expressway as identified in the Strategic Plan will have been rehabilitated, meeting the target set out in the Plan. Regular inspections on the new details such as the flexible link slabs and drainage works, some installed over 7 years ago, have shown no sign of cracking, leaking or distress. The total contract value of C$49.4 M (including deck replacement of the connecting ramps in 1993) for the past 9 contracts agrees well with the original estimate of C$44.7 M (before inflation adjustment). Pilot projects for the substructure repair have already started, and trial projects for new expansion joint systems have also been carried out. However, these are beyond the scope of this paper.

6.2 The writers would like to express sincere gratitude to the late Mr. Andres Tork who had contributed so much to the success of this project, and to METROTransportation Department of Toronto and Morrison Hershfield Limited, who have allowed us to publish the information contained in this paper.

REFERENCES

1. TORK, A., Rehabilitation of Prestressed Concrete Box Beams Deck of an Elevated Roadway, The Canadian Journal of Civil Engineering, Feb., 1989.

2. Morrison Hershfield Limited, Report on F.G. Gardiner Expressway Jarvis Street to Don Valley Parkway, February, 1986

3. Morrison Hershfield Limited, Strategic Plan for the Elevated Section of the F.G. Gardiner Expressway CNE Grounds to Don Valley Parkway, September, 1986

4. TORK, A., Rehabilitation of Steel Girder Deck of an Elevated Expressway, 3rd International Conference on Short and Median Span Bridges, 1990, Toronto, Ontario, Canada