Bridge decks, joints and bearings assessment and maintenance methods

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Bridge Decks, Joints and Bearings Assessment and Maintenance Methods

Méthode d'evaluation et d'entretien des tabliers, des joints de dilatation et des appuis de ponts

Beurteilungs- und Instandhaltungsmethoden für Fahrbahnplatten, Dehnungsfugen und Lager

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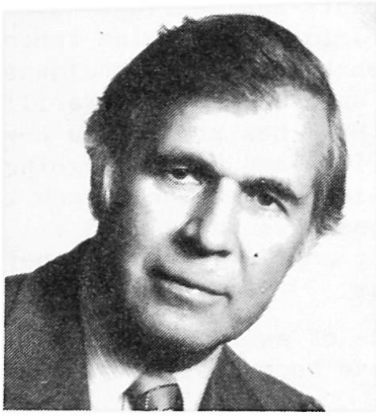

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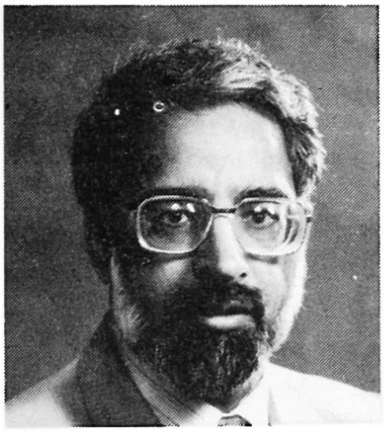

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SUMMARY
Bridge decks, expansion joints and bearings have been the highway bridge elements most susceptible to deterioration from the application of winter deicing salts. Extensive investigation and testing in Ontario have produced methods to assess damage and more effectively maintain bridges. This experience has led to changes in new construction to prevent a repetition of the rapid deterioration evident in many bridges built 20 to 30 years ago.

RÉSUMÉ
Le tablier des ponts, les joints de dilatation et les appuis ont toujours été les éléments des ponts-routes les plus susceptibles de se détériorer du fait de l'utilisation du sel d'épandage en hiver. Des recherches et des expériences extensives ont éte faites en Ontario et ont abouti à la mise au point de méthodes d'évaluation des dommages et de protection plus efficace des ponts. Cette expérience a conduit à modifier la construction des ponts afin d'éviter que ne se produise une détérioration rapide comparable à celle des ponts construits il y a vingt ou trente ans.

ZUSAMMENFASSUNG:
Brückenfahrbahnen, Dehnungsfugen und Lager sind am Meisten dem vorzeitigen Verschleiss und Beschädigungen ausgesetzt, welche durch das im Winter verwendete Streusalz gegen Vereisung der Fahrbahn hervorgerufen wird. Durch weitgehende Untersuchungen wurden in Ontario neue Beurteilungsmethoden entwickelt, welche zur frühzeitigen Entdeckung von Schäden und zur rechtzeitigen Reparatur führen. Die auf diesem Gebiet gemachten Erfahrungen haben auch zu neuen Konstruktionsmethoden beim Bau von neuen Brücken geführt, um eben diese Schäden von Anfang an zu verhindern.

1. INTRODUCTION

Following the large expansion of highway facilities in North America in the 1960's, many of the highway bridges built at that time and since have shown unanticipated early deterioration. This is particularly true in northern areas where there has been extensive winter salting, such as in Ontario. The component most susceptible to this deterioration has been concrete bridge decks, but due to leaking expansion joints many bridge bearings and bridge seats have been similarly affected.

The problems with decks, joints and bearings have been the subject of extensive research and testing in Ontario to determine improved maintenance and assessment methods, as well as rehabilitation techniques and improved new design and construction procedures to ensure greater durability. The Ministry of Transportation of Ontario (MTO) has produced a new bridge design code [1] addressing improved durability, and has an ongoing committee on durable structures to ensure early implementation of new technology. A bridge deck rehabilitation manual has been issued [2] and all deck joints and bearings undergo extensive laboratory and field testing before being accepted and placed on a designated sources list.

This paper describes methods of assessment and maintenance for concrete decks, joints and bearings that have become established practice in the Province of Ontario.

2. DECKS

2.1 Background

In the past, the lack of care in achieving the specified cover to the top layer of reinforcement in deck slabs, the impracticality of putting four layers of steel into the 190 mm deck slab, or the use of improper waterproofing membranes and exposed decks has led to severe deterioration in decks, sometimes in less than ten years from the time of construction.

2.2 Condition Assessment Methods

The first indication that there is a problem with bridge decks usually comes through the biennial inspections. These, however, may not provide sufficient information so general surveys, included chain dragging of the bare concrete decks and limited coring of both bare and asphalt covered decks, may be carried out to establish the extent of the problem, set policies and develop rehabilitation programs.

Detailed deck surveys are also carried out on decks that are on a road paving contract so that the condition of the decks can be assessed and any necessary repairs designed to coincide with the paving contract.

Detailed deck condition surveys[2] include:
- Delamination survey with a heavy chain.
- Corrosion potential survey with a copper copper-sulphate half cell.
- Concrete cover survey using a pachometer (covermeter).
- Concrete coring, and asphalt sawn samples.

The assessment of decks by radar and thermography, DART,[3] gives information on asphalt thicknesses, scaling and delamination of concrete, and concrete cover to reinforcement. This information can be collected rapidly, and with some additional information obtained through coring and half cell surveys will, in future, reduce the time needed for condition surveys.

2.3 Maintenance Practices

Washing of bridge decks, expansion joints, bearings and other components exposed to salt spray is carried out at least once every year on all bridges. Minor repairs are undertaken as required by the bridge crew.

2.4 Rehabilitation Practices

The options for concrete deck rehabilitation used in Ontario are:
- Patch, waterproof and pave.
- Cathodic protection.
- 60 mm of normal slump concrete overlay with waterproofing and paving.
- 50 mm of latex modified concrete overlay.

The selection of the rehabilitation method is based upon practical, economic and technical considerations. The decision matrix for selection of deck rehabilitation method based upon technical consideration is given in Table 1. Quite often the selection criteria does not yield any one type of rehabilitation. In such cases judgement has to be used to arrive at the best solution.

Criterion	Concrete Overlay	Waterproof and pave	Cathodic Protect.
-Delamination and spalls exceeding 10% of the deck area.		No	No
-Corrosion potential more negative than 0.35V over more than 20% of the deck area.		No	
-Moderate or heavy scaling exceeding 10% of the deck area.		No	No
-Active cracks.	No		
-Remaining life less than 10 years.	No		No
-Concrete not properly air entrained.			No
-Complex deck geometry.	No		
-Limited load capacity.		No	No
-Electrical power unavailable.			No
-Epoxy injection repairs.			No

Table 1 Decision Matrix for Selection of Deck Rehabilitation Method

2.5 New Construction

Durability of new concrete construction is assured by a combination of strategies [4],[5].
- The thickness of concrete slab decks has been increased to 225 mm which allows for the tolerances of placing the four layers of reinforcement and still maintain the specified minimum covers to the reinforcement.
- The concrete cover to the top surface of the deck has been increased to 70 $\pm$ 20 mm. Also, the screeds are adjusted to maintain this cover as checked through a dry run of the finishing machine.
- Epoxy coated reinforcing steel is used in surfaces exposed to salt application or spray.
- All concrete decks are waterproofed and paved with asphaltic concrete.
- Details at expansion joints have been improved and all transverse and longitudinal joints are sealed.
- Drip details have been improved.

3. EXPANSION JOINTS

3.1 Background

Thirty years ago most expansion joints were of the open type. With the development of so-called sealed system, these have been used almost without exception to try to prevent corrosive run-off reaching the bearings, bridge seats and other components. Unfortunately these systems have rarely been fully watertight in practice, and the gradual seepage of brine without the flushing effect of summer rainfall has perpetuated the same concerns regarding corrosion.

The ride quality when crossing expansion joints has been an ongoing problem, as has the anchorage of joint components, and traffic disruption caused by joint maintenance and replacement. In an effort to improve joint quality and durability these questions have been addressed by MTO through design provisions in the Ontario bridge code [1], improved maintenance practices, extensive condition assessment of existing joints and testing of new products.

3.2 Condition Assessment

All joints are assessed in the detailed inspection which take place every two years and recorded on the inventory system. Problems between inspections usually become readily apparent by poor ride quality, or evidence of excessive leakage. A survey of expansion joint performance on selected bridges has led to the elimination of elastomeric compression seals as an acceptable sealing system.

The assessment of various methods of anchoring the steel components has led to a standardized system using reinforcing bars cast into the deck (Fig.1). This figure shows the joint system cast into a substantial concrete dam with steel angle armouring. This system has been found to be less susceptible to failures of the joint and adjacent pavement.

Various types of proprietary sealing systems may be used between the steel angles shown (Fig.1) but they have to be approved before being placed on the MTO designated sources list[6]. Approval is only granted after review of detail drawings, laboratory testing of seal material and joint movement, followed by a trial installation and performance assessment after one year in service. The trial installation, and all new joint construction, is subjected to a water leakage test before opening the bridge to traffic. This test is performed by ponding water across the joint through the use of temporary dams, and checking for leakage below the joint. This test is considered to be one of the most important procedures introduced to improve performance, as evidenced by frequent leakage when joints are first installed and tested.

3.3 Maintenance Practices

Sealed joints are cleaned out periodically, but there is usually an accumulation of sand and debris that can inhibit the free closure of the joint in hot weather. In cases of extreme wear or damage, the seals may be replaced as a maintenance item. To minimize possible leaks at jointing of seals, full length seals are preferred.

To facilitate cleaning of any salt water leakage through the joint, a minimum gap of 200 mm is specified between the deck and the face of the abutment wall (Fig.2). All construction formwork must be removed from this gap.

3.4 Joint Selection

The designated sources list[6] has a number of approved joints, but the most widely used are strip seal joints anchored in concrete. The joints in this category have been placed in a number of classes, according to the various seal clamping methods used. Based on the asessment and field performance results, guidelines have been prepared showing the suitability of the joint classes for various highway classifications[7]. For high volume freeway applications, classes using a heavy horizontal steel plate to clamp the seal are preferred (Fig.1). For the most severe applications the press fit seal retainer class is not used. The guidelines, which are for the use of the designer, also list other characteristics, both positive and negative, such as robustness, installation cost, seal retention, ease of installation and replacement, and access for inspection.

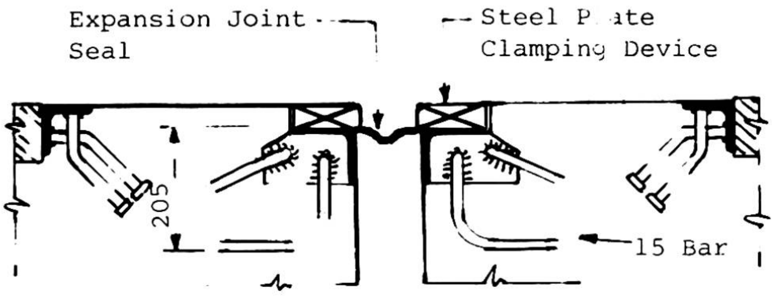

Fig. 1 Expansion Joint Anchorage

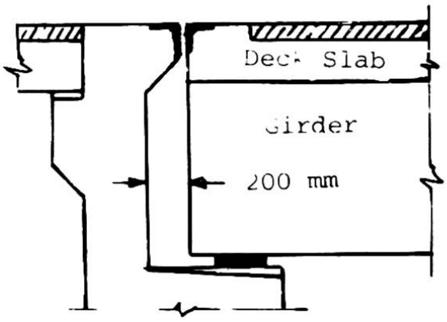

Fig. 2 Detail at Abutment

4.0 BEARINGS

4.1 Background

Simple bearings such as sliding plates, rockers and rollers were widely used in Ontario until the mid 1950's. These types were particularly susceptible to corrosion and seizure with the open expansion joints prevelent at that time. Since the introduction of steel laminated elastomeric bearings in 1957, this type has been commonly used.

In the early 1960's the newly developed pot bearings proved to be the preferred type for the single round columns which were extensively used for post-tensioned concrete construction. This type of construction has become the first choice for expressway structures, and TFE lined spherical bearings and polyurethane disc bearings are now also used in this type and other long span structures.

4.2 Condition Assessment

Bridge bearings are inspected every two years on a regular basis, but in 1986 the MTO carried out a special assessment to cover all types of bearings in use at that time. The results of this study have been published[8], and will have a significant affect on bearing design, selection, and maintenance in Ontario.

Unconfined elastomeric bearings have been used for 30 years and their satisfactory performance was confirmed by this study. Elastomeric bearings have been subject to testing of materials in the laboratory and samples taken at the site for quality assurance testing. There have been many failures, particularly of bond between laminates during these pre-installation tests.

The pot, spherical and disc bearings are more complex in their manufacture and operation than the elastomeric bearings. As might be expected several types of deficiency and failure were observed. The study lists eleven types of defect on pot bearings and TFE sliding surfaces, with possible causes and corrective action to be taken. Largely as a result of this report, the Ontario specifications for bearings have been re-written [9].

The MTO uses proprietary type bearings which are prequalified and placed on the designated sources list. This list is presently being revised following new bearing qualification methods. To be designated, a bearing manufacturer must submit shop drawings and design calculations for approval, a sample of elastomer for testing, and finally a sample bearing for evaluation.

4.3 Maintenance Practices

Bearings have not been cleaned well in the past, and steel parts have corroded badly. To facilitate general cleaning, a 200 mm gap is provided to the abutment wall (Fig.2). A higher degree of corrosion protection is now specified for new bearings, and bearings must be replaceable without damage to the structure. To assist free draining around the bearing, inclined bridge seats are now specified (Fig.2).

5. CONCLUDING REMARKS

The methods for carrying out condition surveys and asessment of decks in Ontario should ensure a better selection of rehabilitation methods than in the past. The emphasis on durability in design codes should provide a longer life for new deck construction.

Proprietary expansion joints and bearings are used, but performance specifications or guarantees are not considered practical at this time. Instead, comprehensive requirements are given in the design code and the material and construction specifications, with prequalification of suppliers by extensive testing and inspection. Combined with improved maintenance methods, this approach is expected to provide more durable joints and bearings to combat the corrosive Ontario environment.

6. REFERENCES

1. MINISTRY OF TRANSPORTATION, Ontario Highway Bridge Design Code, 2nd Edition, 1983.
2. MANNING, D.G., and BYE, D., Bridge Deck Rehabilitation Manual, Ministry of Transportation, 1983.
3. MANNING, D.G., and HOLT, F., The Development of Deck Assessment by Radar and Thermography, Ministry of Transportation, ME-83-03, 1983.
4. REEL, R., and MANNING, D.G., The Chloride Content of Concrete Bridge Decks in Ontario with Particular Reference to Deck Soffits, Ministry of Transportation, ME-86-01, 1986.
5. MANNING, D., A Rational Approach to Corrosion Protection of Concrete Components of Highway Bridges, Ministry of Transportation, ME-86-06, 1986.
6. MINISTRY OF TRANSPORTATION, Designated Sources List DS141 for Bridge Expansion Joint Assemblies, 1987.
7. MINISTRY OF TRANSPORTATION , Guide for the Application of Designated Sources List DS 141 for Bridge Expansion Joint Assemblies, Structural Manual, 1986.
8. MANNING, D.G., and BASSI, K.G., Bridge Bearing Performance in Ontario, Ministry of Transportation, ME-87-03, 1987.
9. MINISTRY OF TRANSPORTATION, OPSS 1203, Material Specifications for Bearings - Rotational and Sliding Surface, 1986.