Ministry of Transportation
Highway Standards Branch
Bridge Office Report

Nipigon River Bridge West Abutment Bearing Technical Investigation

BRO-059

1. Executive Summary

On January 10, 2016 at 3:05 pm, the Nipigon River Bridge was closed to traffic. The bridge became impassable after the failure of 40 (7/8" ASTM A490) bolts at the northwest bearing caused the bridge to lift approximately 600 mm at the northwest corner. This report summarizes the Ministry of Transportation's technical investigation into the cause of failure. Factors pertaining to the management of the project are not the subject of this report.

The technical investigation into the failure involved;

1. testing of the bolts,
2. structural analysis of the northwest bearing and the associated connections to the bridge girders and abutments,
3. evaluation of components in the load path from the girder to the west abutment according to the Canadian Highway Bridge Design Code (CHBDC) requirements.

The bolt testing was carried out at two independent laboratories, the National Research Council (NRC) in Ottawa Ontario and Surface Science Western (SSW) at Western University in London Ontario. Each laboratory issued comprehensive reports and their findings were reviewed as part of this report. The testing revealed that the bolts met the requirements of applicable standard ASTM A490 and the CHBDC requirements for use of steel in cold weather and were therefore not the reason for the failure at the northwest bearing. Detailed examinations of the bolt failure surfaces by the above laboratories, as well as visual inspection by the Ministry, found that the failure surfaces had striations consistent with low-cycle high-stress bolt failure. In addition, corrosion was observed on some of the failure surfaces, indicating that the failure was progressive and began prior to January 10, 2016.

The structural analysis of the bearing and its connections to the adjacent components of the bridge revealed that the failure was caused by;

1) prying effects due to the flexible shoe plate leading to higher forces in the exterior line of bolts,
2) the bearing's inability to accommodate rotation leading to higher forces in the end rows of bolts,
3) the lack of pretensioning of the bolts and lack of bevelled washers that lead to

high fatigue stresses and a high-stress, low-cycle fatigue failure.

Each of these of factors on its own is significant and could have led to a failure, but combined they made failure inevitable. Other factors which also contributed to and accelerated the failure include local bending of the bolts and yielding of the shoe plate.

The evaluation showed that the shoe plate, bolted connection between shoe plate and girder, bolted connection between shoe plate and bearing, and bearing design all failed to meet the requirements of the CHBDC.