

## *Project Overview*

### *Purpose of the Project*

The Michigan Department of Transportation (MDOT) presently has in its inventory of structures several bridges that are non-redundant and fracture-critical. Responsibility for inspection and maintenance of these structures has moved from the Maintenance Division in Lansing to the various Regional Offices where the bridges are located.

Along with that relocation of responsibility, the MDOT wishes to create a manual that explains the special nature of this type of structure, discusses the unique features of each bridge, and is instructive regarding inspection and maintenance practices. This manual will consider only those bridges which are both non-redundant *and* fracture-critical. MDOT structures which are only non-redundant or fracture-critical are not a part of this document. This manual is intended for use by Region staff to enable them to plan for inspections and maintenance activities and to anticipate items that may need either routine or periodic attention.

The manual is not intended to be a substitute for a comprehensive course on inspecting and evaluating fracture-critical/fatigue-sensitive structures and assumes that the user has been trained and has some experience in the fundamentals of bridge inspection. The intent of the manual is to remind the user of the basics and to focus on the specific issues relative to these structures.

The manual is separated into three sections. The first gives an introduction to the project. The second briefly describes the issues affecting these structures and why they can be problems, methods to determine if a given bridge has a problem, and the steps to take to correct these problems. The third discusses each bridge and the specific issues affecting them.

### *URS Greiner Woodward Clyde Approach to the Project*

The work performed by URS Greiner Woodward Clyde (URSGWC) for this project was divided into three distinct areas: Data Collection, Site Visits/Interviews, and Manual Preparation.

**!** **Data Collection.** URSGWC collected existing plans (original construction and rehabilitation), other contract documents, previous inspection reports, and research reports, as available. A complete listing of document sources within MDOT is included in the Reference Material Section. The documents were reviewed to identify fracture-critical members, fatigue-sensitive details, and any other unusual features or potential problem areas that should receive special attention during periodic inspections. Some of the details from those plans are incorporated herein.

! **Site Visits/Interviews.** A team consisting of a registered Professional Engineer and a Certified Bridge Inspector from URSGWC conducted site visits to each bridge in the MDOT’s inventory of non-redundant bridges. The primary purpose was to familiarize the team with each structure and its environment. When necessary, some details were carefully inspected to gain a greater understanding of those features and their current conditions. Typical and specific details and problem areas were photographed for inclusion in the manual.

URSGWC developed a questionnaire to use during interviews with Regional MDOT staff including the Bridge Engineers, Inspectors, Supervisors, and Foremen. The intent of the interviews was to gain added information and to identify other problem areas and historical perspectives that may not be identifiable from available documents. Information from these interviews was incorporated into the individual sections for each bridge at the end of the manual. Copies of those interview forms are included in the section dealing with each individual bridge.

! **Manual Preparation.** It is MDOT’s intention that the primary manual users will be Region Bridge Maintenance Foremen and Bridge Inspectors. The manual was prepared and includes, among other things, inspection and maintenance recommendations for MDOT’s non-redundant bridges.

### ***Big 12 Bridges***

In June 1983 a portion of the Mianus River Bridge in Connecticut collapsed, causing the death of several people. This bridge was a two-girder, non-redundant, and fracture-critical structure and the collapse was attributed to the failure of one of the pin and hanger assemblies. The national news media brought the disaster scene and the National Bridge Inspection (NBI) Program into sharp focus.

MDOT, along with most other DOT’s, examined its structure inventory to determine if there were any potential problems of a similar nature. From this examination the “Big 12” list was developed. After an inspection of all of the structures it was decided to begin a program of replacing the pins and hangers and to perform inspections of certain elements of the structural systems with greater frequency than required by the NBI.

The Bridge Inspection Section within the Maintenance Division performed an inspection of the fracture-critical elements on these structures on a yearly basis and continued the NBI inspection biennially after the repairs were completed. This was done to ensure that the structures would always be closely evaluated even as people rotated through the Bridge Inspector position.

In 1998, MDOT developed and received management approval of the “Strategic Investment Plan for Trunkline Bridges.” One of the issues this plan recognized was the need to centrally manage the large, costly bridges. The “Big Bridge Committee” is now charged with this task. After the decentralization of

the Bridge Inspection Program and with the formation of the Big Bridge Committee, consideration was given to retaining the Fracture-Critical / Non-Redundant subset of bridges under central management.

However, these structures are not large enough to meet the requirements established by the Committee for a “big bridge,” so they will remain the responsibility of the Regions. In an effort to give the Regions support in the management of these structures, this Maintenance Manual will discuss those aspects of these structures that require extraordinary investigation and will make suggestions of what to look for in a generic sense.

All of the girder structures in the Big 12 bridge inventory consist of two-girder systems with the exception of two pairs of bridges and an additional individual bridge. Bridges B01 and B02 of 11057 (U.S. 31 over the St. Joseph River in Niles) are continuous welded plate girder bridges that have three main girders with floorbeams and stringers. Bridges B01 and B02 of 23151 (I-96 over the Grand River in Windsor Township) have four welded plate girders with pin and hanger connections. Bridge R03 of 58151 (I-75 over the Raisin River in Frenchtown Township) has four riveted plate girders with pin and hanger connections. Each of these bridges have a very wide spacing of the primary girders. An engineering analysis has been performed for each bridge and due to the wide girder spacing, it was concluded that a failure of one girder may precipitate a failure of adjacent girders. Due to their unusual details and the potential that they may behave as true non-redundant bridges, these two pairs of structures have been included in the Big 12 inspection program and should receive annual inspections.

This document is intended to provide information specific to this set of bridges and to assist an experienced inspector with the details of a fracture-critical inspection at each site. The inspector should be familiar with and understand the structural systems of each bridge and be alert to deterioration at sites other than the fracture-critical details.

MDOT places a high priority on the maintenance and inspection of these bridges because the unique configurations of these structures make failure of certain members potentially a catastrophic occurrence. The bridges are inspected frequently to identify small problems or potential problems at an early stage and correct them. Preventative maintenance is an important and easy method to keep the high costs associated with rehabilitation of these types of bridges from being necessary.

Another major factor affecting the need to preserve these structures is that they typically cannot be rehabilitated with staged construction. Closing of a bridge may require long detours.