

**MICHIGAN STRUCTURE INSPECTION MANUAL
BRIDGE INSPECTION**

CHAPTER 9

DAMAGE INSPECTION

9.01 Purpose

The National Bridge Inspection Standards (NBIS) require each state to establish criteria to determine the level of detail required for damage inspections. Damage inspections are defined as an unscheduled inspection to assess structural damage resulting from environmental factors or human actions. The majority of damage inspections in Michigan are the result of vehicle or vessel impact to components of a bridge. Occasionally the damage causes instability of one or more primary members and reduces the safe load capacity until engineered repairs are performed. When the damage is substantial and warrants closure of a shoulder, lane, or entire bridge it is considered a critical finding that must be reported to FHWA. Timely response is required to protect public safety. A damage inspection and accurate documentation must be performed to execute repair activities. Proper reporting of the damage is also required for an efficient arbitration process or favorable court ruling that will allow for the recuperation of costs associated with the inspection and repair activities.

9.02 Types of Damage Inspections

The levels of damage inspection may be organized into three types that aid in defining the effort, anticipated requirements, and characteristics of the damage. The suggested guidelines have been provided for the bridge owner and may not directly apply to every circumstance encountered. It is the bridge owner's responsibility to decide which level of damage inspection must be utilized in order to gather accurate data that will ensure public safety.

Type I Damage Inspection:

A Type I inspection shall be completed when minor damage has occurred that was not previously documented or reported. This type of inspection is conducted at distances normally associated with a routine bridge safety inspection where immediate repair work and testing is determined to be unnecessary. Generally, a Type I inspection is satisfactory for unreported vehicle impact damage with the observed defects that include surface scrapes to the protective coating of primary or secondary members, primary member distortion of 2" or less with no bending near secondary member connections, or shallow spalling that does not exceed 6" in width without cracking.

Documentation shall occur on the Bridge Safety Inspection Report (BSIR) during a scheduled routine bridge safety inspection or damage inspection report for unscheduled inspections. Photographs with comments describing the damage and associated elements shall be provided. If any concern exists following the conclusion of the inspection a Request for Action (RFA) will be submitted to the bridge owner. The bridge owner is responsible for reviewing the RFA in order to determine whether a Type II inspection or other additional action must be coordinated.

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Type II Damage Inspection:

A Type II inspection shall be completed whenever damage has occurred that is reported by law enforcement, the degree of damage exceeds the limits specified for the Type I inspection, or when engineering judgment dictates a need for hands-on inspection. Documented damage is provided by law officials through the issuance of a State of Michigan Traffic Crash Report (UD-10) to the agency. This type of inspection is conducted at arms-length in order to verify the requirements of repair work that may be scheduled or to provide a detailed historical record of any deformations that exist. All vessel impact and fire damage inspections should also begin with a Type II damage inspection in order to accurately assess whether affects to structural capacity occurred.

Detailed measurements and photographs of all the affected elements shall be documented on the damage inspection report. It is also recommended to update the BSIR and provide reference for the inspection work or repairs that are installed. If any concern exists following the conclusion of the inspection an RFA should be submitted to the bridge owner. The bridge owner is responsible for reviewing the RFA to determine whether a Type III inspection or other additional action must be coordinated.

Type III Damage Inspection:

A Type III inspection shall be completed when critical damage to the primary structural elements causes concern for stability or loss of safe structural capacity. The majority of these inspections are initiated by verbal contact from law enforcement, although they may also result following observations during the Type I or II damage inspection. This inspection must be performed as soon as the scene is safe for individuals and equipment to access the affected component.

Detailed measurements and photographs of the damaged elements shall be documented on the damage inspection report. When immediate repairs are necessary a narrative of the activities completed shall also be provided. Additional actions may be necessary following the inspection which should be documented on the RFA form. The bridge owner is responsible for reviewing the RFA, facilitating the necessary actions to resolve the matter, and updating inventory coding. All damage that results in a critical finding must be documented on the RFA form.

9.03 Damage Inspection Procedures

Since damage inspections are unscheduled events, whereby extensive resources may not be available to immediately respond, communication is vital during the entire process. The bridge owner is usually the first to be informed of reported damage and often responds directly to the incident. The bridge owner may delegate the responsibility of completing the damage inspection to a qualified individual. Although processes may vary according to agency specific guidelines, the bridge owner is ultimately responsible for initiating any required reactions stemming from the reported damage and coordinating the immediate or intermediate actions that must be undertaken. The course of action taken to ensure public safety will be unique for many incidents and depend upon the extent of damage or the resources available to mitigate public mobility impacts.

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The procedures that have been developed are guidelines for the bridge owner and responding individuals to follow. The bridge owner or delegated authority responsible for assessing the damage may decide to deviate from established practices according to the particular conditions encountered and the degree of damage present. However, the bridge owner must ensure that the level of response is appropriate for each reported incident, the damage is well documented, and confirm that follow-up activities to maintain public safety are accomplished.

9.04 Damage Inspection Procedures – High Load Hit Impacts

On average, MDOT owned bridges experience more than one reported high load hit (HLH) per week. There are also numerous un-reported HLHs that occur which are often minor and discovered during scheduled routine inspections. Factors influencing the frequency of impacts include the relative state of the economy, seasons, and population density as they all affect the transportation of equipment and materials in a variety of ways. In many cases the resulting damage from each HLH is unique and may be limited to minor aesthetic losses or extensive destruction that affects safe load capacity.

When the bridge owner or delegated authority responds to the site of reported damage and the roadway is not closed the inspection must begin at a safe distance from traffic, usually on the shoulder of the route under, in order to determine the urgency of the Type II inspection. These cases occasionally occur for instances when the notification of damage is first reported to the bridge owner through the distribution of a UD-10 in the Traffic Crash and Reporting System (TCRS). All recently damaged bridge elements must be carefully inspected for signs of damage or distortion. Freshly scraped protective coatings on steel stringers and light colored spalling of concrete beams or the deck provide initial signs where the reported impact may have occurred.

The previous BSIR or damage inspection report should be reviewed when the inspector is unaware of the damage history at the particular location so any existing damage is not contributed to the most recent impact. Once the location of impact is determined the extent of it must be well defined. If the damage is not readily identifiable the bridge owner should review all of the primary components and contact the responding law enforcement official for more information.

If there are no immediate concerns following the initial review of the damage a Type II inspection may be completed at any time. Although a follow-up inspection will be performed the Type I inspection must be documented through completion of a damage inspection report and/or updating the BSIR to document the observed damage. This initial record should approximate the extent of distortion, categorize any damage to secondary members, and provide photos for the file. The report may be amended once detailed measurements have been taken during the Type II or Type III inspection. This action will allow for the proper identification of any additional impact damage that occurs prior to the follow-up inspection.

When the vehicle that impacted the bridge is at the site during the inspection the immediate course of action will be contingent on whether or not law enforcement is present. If law enforcement is not present, they shall be contacted immediately so assistance to the vehicle operator and any other affected motorists may be administered. The bridge owner must exercise judgment when approaching the scene

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without emergency response officials present. If the vehicle is transporting cargo that may be hazardous the bridge owner shall abstain from any further actions until law enforcement has determined that any associated risks to health and safety have been resolved.

In rare instances portions of the vehicle or cargo may become entangled in the bridge elements and require removal. Under no circumstances shall portions of any primary or secondary bridge elements be modified or cut to facilitate the removal without approval from the bridge owner or Statewide Emergency Coordination Engineer. The owner of the vehicle is responsible for removing their property from the site without causing any further damage to the structure unless arrangements cannot be completed in a reasonable timeframe.

The bridge owner shall follow any agency specific processes and procedures to notify individuals in preparation of maintaining traffic and releases to the media. If the agency does not have written guidelines the bridge owner shall, at a minimum, arrange for the installation of traffic control devices and notify the jurisdictional MDOT Transportation Service Center (TSC). The bridge owner must then determine whether the affected primary members are stable and if the impact has had a negative reduction in the safe load capacity of the structure. Since lane closures are necessary to remove the equipment and damage may be extensive, a Type II or Type III inspection should be performed once the components are accessible.

9.04.01 High Load Hit Impact Procedures – Steel Superstructure

During a Type I inspection the steel superstructure and deck components shall be inspected to determine whether immediate action must be taken. The bridge owner or team leader must determine the approximate amount each stringer is bent out-of-plane, record the length of the distortion, and document the point of impact. The limits of the affected damage must be identified by reference points, usually from the beam ends, in order to provide a baseline for comparison if additional damage occurs. Photos shall be recorded along the length of the affected stringer(s), point of impact, and any damaged connections. This information also aids the development of a traffic control plan should further action be necessary. An RFA should be submitted to the bridge owner anytime additional work must be completed.

The Type II or III inspection is completed to determine the exact extent that each member is distorted or damaged. This process usually begins by placing a four foot level vertically plumb from the edge of the top flange and measuring the horizontal distance from the affected bottom flange near the maximum point of distortion. The length of the distortion must also be determined and should be measured from a known reference point. A sketch of the damage should be drafted on an as-built plan sheet or drawing if the plans are unavailable. If the bottom flange is rotated vertically measurements shall be taken on the outside edge of each side to the top flange. Any damage to secondary members or connections must be documented. Dye penetrant or magnetic particle testing shall be used to assist in the verification of suspected cracking or may be employed to confirm that cracking has been properly arrested. Cracks in elements that are not redundant often require an immediate action. Any work that requires further evaluation or repair should be documented on the RFA form for further action.

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9.04.02 High Load Hit Impact Procedures – Concrete Superstructure

During a Type I inspection concrete superstructure and deck components that have been impacted require inspection for cracking and spalling. Secondary members such as concrete or steel diaphragms should be examined for damage. The bridge owner must determine the size of spalls, approximate the area of observed cracking, and document the point of impact. The limits of the affected damage must be identified by reference points, usually the beam ends, in order to provide a baseline for comparison if additional damage occurs. Photos shall be recorded of the bottom flanges of all affected beams, the point of impact, and any damaged connections. This information also aids the development of a traffic control plan should further action be necessary. An RFA should be submitted to the bridge owner anytime additional work must be completed.

The Type II or III inspection is completed to determine the exact extent that each member is damaged. The inspector should sound the affected beam(s) and fascia to detect the presence of delaminations and mark them with marking crayons or sprayable chalk. Spalls, delaminations, and cracks shall be accurately measured and the locations of them identified by a known reference point on the bridge. The damage shall be drafted on an as-built plan sheet or drawing if the plans are unavailable. A Type III inspection shall be completed whenever there is severed prestressing reinforcement, vertical beam cracking, or testing required for structural load capacity verification.

9.05 Damage Inspection - Fire Damage Procedures

All damage that has resulted from fires requires a level II or level III damage inspection. Fire damage to bridge components often results from the accidental combustion of flammable materials in transit but may also occur due to intentional human activities. The extent of heat damage affects the fundamental bridge materials of steel and concrete in various ways. Strength loss for each type of material varies according to the fuel source, duration, and distance of the fire. Once the site is safe for inspection the bridge owner must determine the limits that were affected, degree of damage, and whether Type III testing is required to verify if strength reductions have occurred. The results of any required test will allow for an accurate load rating to be accomplished and aid in the determination of whether repair or replacement of the element is necessary.

The inspection should begin by reviewing the exposed components for signs of damage. If distortion or cracking are not readily apparent, soot should be removed from the surface in order to identify deficiencies. A sketch of the area affected by the heat should be created to allow for defect observations to be recorded.

The inspection of steel elements may begin by verifying the condition of protective coatings on stringers. Proper precautions should be exercised while working around damaged paint coatings as they may contain lead. If the coating has been damaged by the heat source further inspection is required to verify whether a reduction in yield strength has occurred. Substantial impacts to steel tensile strength generally occur when temperatures reach approximately 1200 °F, but are dependent on the duration and intensity of the heat. If the coating has been damaged but the steel does not exhibit signs of deformation or

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obvious damage destructive testing may have to be performed. For MDOT owned bridges, the bridge owner shall contact the Bureau of Bridges and Structures to provide guidance and specialized testing services. Local agency bridge owners are recommended to secure a consultant capable of performing the evaluation. A series of coupons may need to be extracted to perform laboratory tension and impact testing in order to determine whether repair or replacement is necessary.

Reinforced and prestressed concrete must be evaluated for cracking, delamination, and spalling following a fire. Generally, concrete heated to 900 °F will lose approximately 50% of its compressive strength while losses will also be realized to reinforcement bond and tensile capacities. Sounding must be performed to characterize whether the intensity of the heat source affected the properties of the concrete. Delaminated areas should be clearly defined with marking paint. Concrete that spalls or crumbles to reinforcement while impacting with a rock pick hammer indicate heat exposure that may have load capacity implications and requires further destructive or non-destructive testing of the materials. Samples of concrete or steel reinforcement may require extraction to categorize strength loss and verify the presence of micro cracking.

9.06 Damage Inspection – Movable Bridge and Vessel Impact Inspection Procedures

Damage inspections of movable bridges are often warranted due to operational errors or electrical, mechanical, and hydraulic failures. Detailed guidelines pertaining to the inspection of movable bridges may be reviewed in the AASHTO *Movable Bridge Inspection, Evaluation, and Maintenance Manual*. It is recommended that each movable bridge have bridge specific operations and maintenance manuals. The information in the manuals will provide a basis for the bridge owner or consultant to begin troubleshooting mechanism malfunctions.

Impacts caused by vessels in navigable channels may cause damage that cannot readily be detected during a Type I damage inspection. Due to the often difficult nature of inspecting the locations of vessel impact on the superstructure, substructure, or protection system components a Type II damage inspection should be performed for all reported instances where commercial ship contact has occurred.

An underwater diving inspection may be required to verify the presence of cracking, distortion, or other defects requiring repair. The inspection should also be focused on reviewing the condition of the protection systems that are employed and appraise their current condition. The AASHTO *Guide Specification and Commentary for Vessel Collision Design of Highway Bridges* provides additional information and current practices in the employment of protection systems.

The observations during the Type II damage inspection must be noted on the damage inspection report to identify the condition and location of the affected elements that are above and below water.

For MDOT owned movable structures the bridge operator shall contact the Bridge Emergency Coordination Engineer when a bridge requires maintenance or is not functioning. The Bridge Emergency Coordination Engineer will complete all necessary notifications to the U.S. Coast Guard, MDOT personnel, and arrange for corrective action.

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Local agency bridge owners are responsible for immediately contacting the U.S. Coast Guard of any incident that restricts the movement of vessels.

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9.07 Documenting Damage Inspections

The bridge owner or individual performing the Type I, II, or III inspection must document the damage found during the inspections. For Type I inspections this documentation should be completed by updating the BSIR, or if the report cannot be updated than a damage inspection report must be completed. The location and extent of damage should be clearly described so it can be compared with any future damage that occurs. In instances where the bridge owner delegates the damage inspection to the team leader that entered the previous Bridge Safety Inspection Report (BSIR) a comment and supporting information shall be added to the document that references the damage inspection. Vague comments such as “slightly”, “minor”, or “about” should never be used to describe damage on any inspection report.

Documentation for Type II and Type III damage inspections shall be more detailed to include sketches and precise measurements of the damage. As these types of inspections often result in legal action against the company that caused the damage to the structure the documentation should be complete and accurate.

9.08 Obtaining the Traffic Crash Report

A UD-10 should be secured by the bridge owner following any damage caused by the driver of a vehicle. For instances where damage is verbally reported by law enforcement, the bridge owner should record the reporting officers contact information for follow-up assistance in obtaining the documentation. The information contained is critical for the recuperation of any inspection or repair costs associated with the incident.

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9.09 Initiating the Claim Process

Local agency bridge owners that are unfamiliar with their agency specific claim process should contact an attorney representative to determine the documents, billing rates, and information needed for the recuperation of damage costs. In order to recuperate costs from damage stemming to an MDOT owned bridge, an estimate must be provided to the Claims Coordinator. The Claims Coordinator is responsible for assembling the information and submission to the Attorney General's Office. Region specific processes should be followed to ensure that costs for each incident are reported. At a minimum the information should include:

- Traffic Crash Report
- Inspection, Evaluation, and Review Cost Report
- Repair Cost Report
- Previous Bridge Safety Inspection Report
- Damage Inspection Report
- Photos

The Inspection, Evaluation, and Review Cost Report include information for labor, equipment, travel, and materials. Labor documentation should include the classification of the employees performing the inspection, their hourly rate, regular time, overtime, and a subtotal for each. The fringe rate provided by the Financial Services Division must be applied to all labor costs for an accurate submittal.

Equipment used to respond to the incident and for access to perform the inspection must also be included. Equipment numbers shall be identified for each unit used. If the hourly chargeable rates are unknown the Operations Administrative Services Division may be contacted for assistance.

Travel costs, including meals and lodging should be provided using the reimbursable rate provided by the Travel Services Division. Materials that are used to facilitate the inspection shall be documented as well. A subtotal of these costs followed by the acceptable rates that may be applied shall be included for the total cost of inspection. For bridge repairs, the Repair Cost report may include similar costs as the inspection and evaluation, but a detailed breakdown of materials used for the repair is necessary.

The most recent Bridge Safety Inspection Report must be provided as a document to identify the change in condition. In cases of a HLH, the defense attorney reviews the superstructure comments provided in the report for vague information relating to previous impact to dispute the case. It is essential for accurate comments to be provided during a routine bridge inspection. The damage inspection report should provide a detailed summary of the affected components that includes measurements and a narrative of the observations identified that were caused by the incident. Photographs that validate the findings shall be recorded and appended to the report.