Substructure Elements and Assessments

1.1 Title

Welcome to the Structure Inspection Refresher Training Series. This module details important information on substructure elements and assessments that inspection team leaders should use to improve inspections.

1.2 Objectives

At the end of this session, you will be able to:

- Distinguish between steel pile and column elements. Properly code these elements.
- Evaluate corroded steel pile and column elements
- Know how to code different wingwall cases.
- Determine the extents of abutments and wingwalls.
- And Know the different types of crash walls and how to code them.

1.3 Pilevscolumn

Structural piles are an example of an element commonly miscoded during bridge inspections throughout Wisconsin. Although structural piles function similarly to columns, they need to be coded separately in the element inspection.

Here's the difference:

- Piles are driven and typically make up a pile bent, which consists of a pile cap and piles. The piles are the foundation of the bent.
- Columns are usually supported by a footing and may be constructed as drilled shafts.Checking over structural plans is a good way to determine the correct element prior to inspection.

1.4 Steel

Element 225, Steel pile, and Element 202, Steel Column, are commonly miscoded on inspection reports.

In general, Steel column elements are rare in the Wisconsin bridge inventory, compared to piling, which is prevalent.

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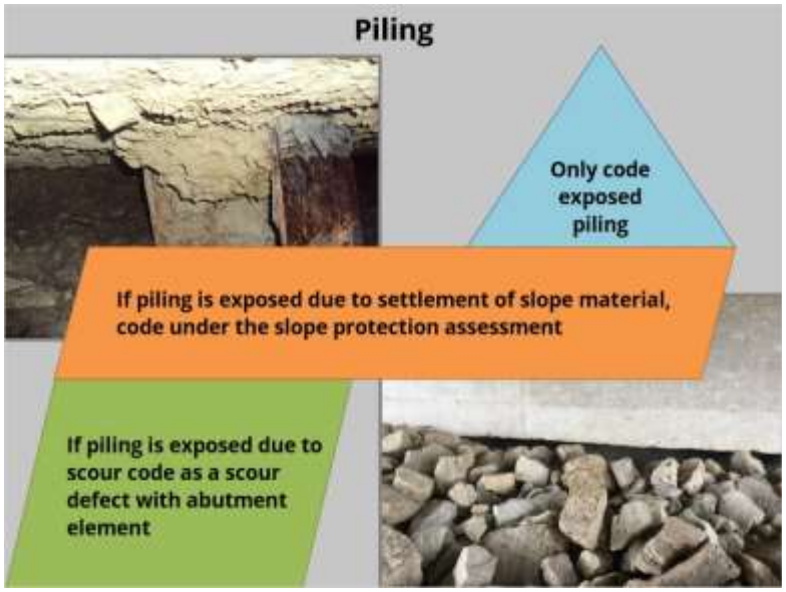

Covered piling, located under an abutment body, should not be reported unless it is exposed.

Only the exposed length of piling should be used to evaluate the condition state of the whole pile.

The picture shows a void under an abutment with exposed piling.

How such a void should be categorized in an inspection will depend on how it developed.

For voids resulting from material settlement below the abutment, code under the appropriate slope protection assessment. Inspectors should describe size and location of the voids.

This void could also be mentioned in the notes under the abutment element.
Voids resulting from a waterway should be listed as a scour defect under the appropriate abutment element.

Also include a Maintenance item to fill the void under the abutment.

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When a bridge has piles supporting the wingwalls, evaluate these piles under the Integral Wingwall Element (8400). Only piles that support the superstructure are to be coded under element 225 Steel Pile.

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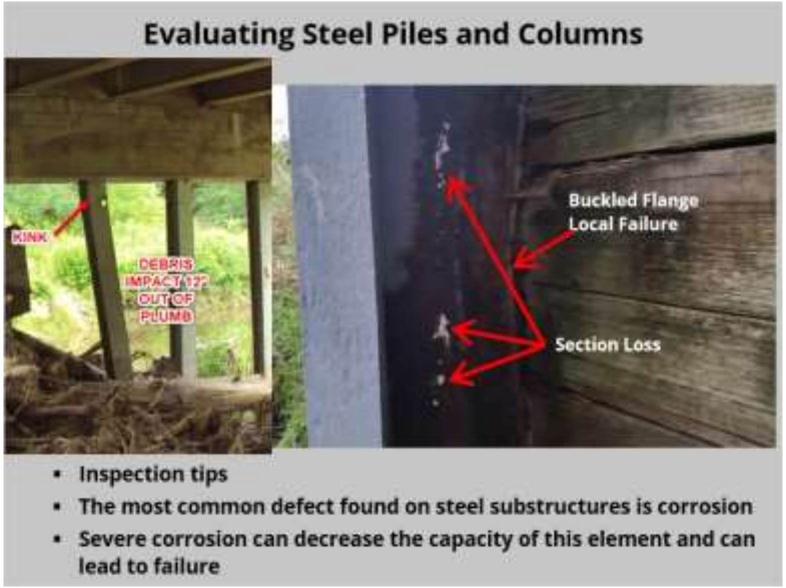

An inspection of steel piles and columns should include the following:

- Look for local compression overload damage in the form of local member component buckling, plate waviness or crippling. This may be evident near the ground line of abutment piles where maximum bending compressive stresses occur.

- Look for global buckling which will take the form of a bow or sweep in the member. This could be the result of a structural overload or differential settlement.

- Examine the member ends for cracks and loose fasteners. Suspect fasteners may be checked for looseness by twisting by hand or tapping the heads with a hammer.

- Check corroded areas for excessive section loss that may be increasing member stress. Additional attention should be given to these elements adjacent to the splash zones of roadways, near the water line, ground line, mudline or cap/pile interface for water crossings, and any detail that would tend to trap water and debris.

- Inspect for cracking and distortion, such as a kin that would suggest the member has experienced collision damage.

- Check to ensure connections on the bottom or top are functioning as intended.

- Check to ensure the element is plumb. This can be done visually, with a plumb bob or with a level. Record measurements if out of plumb.

*The most common defect found on steel substructures is corrosion.

<u>*Severe corrosion can reduce the capacity of these elements and can lead to failure.*</u> As shown in the photo.

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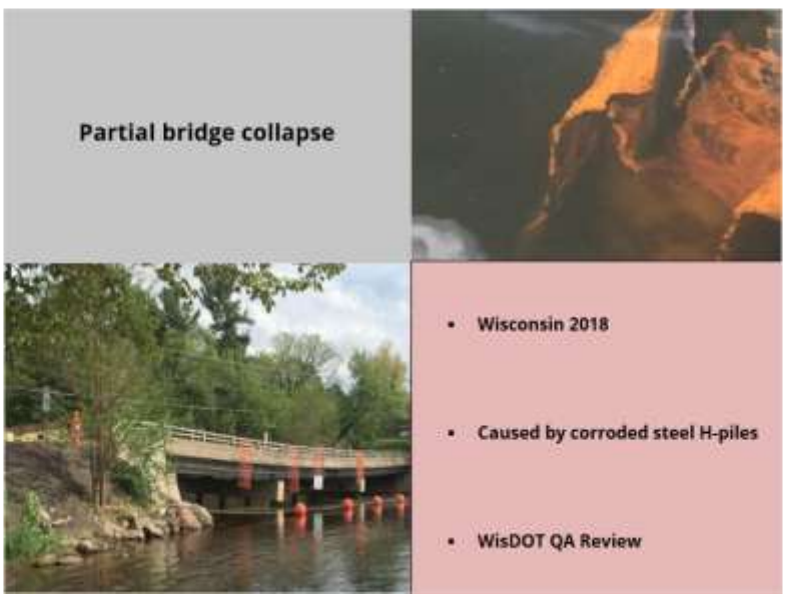

You're now seeing images from the partial collapse of a local 3 span bridge in Wisconsin that occurred in 2018. The steel H-piles at the piers had severe corrosion and buckled under load. Because of this partial bridge collapse WISDOT conducted Quality assurance reviews on a subset of bridges composed of steel piles and columns statewide. From the review, several piles were found to be in severe condition that would be considered condition state 4.

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One big take away from the QA reviews is the need to remove corrosion to properly evaluate the condition of the pile or column element. This corrosion is most commonly found near the waterline, ground or mudline, and cap interface. However, there can be other causes as well.

The following is a video that shows a way to remove laminate rust to adequately expose the remaining struct

structural steel cross sectional area of the element for measurements. Using a caliper or micrometer works well for measuring each flange. An ultrasonic thickness gauge also known as a D-meter may give you the web thickness depending on the surface condition otherwise you may have to approximate the section loss as accurate as possible.

For steel cast-in-place piles or pipe piles A D-meter may also help in determining the thickness of the steel shell (see picture for an example of a D meter). . Check these types of piles to see if they are hollow and compare to the as-built plans to see if this was the designer's intent. If it wasn't the intent a structural review of the pile(s) should be conducted.

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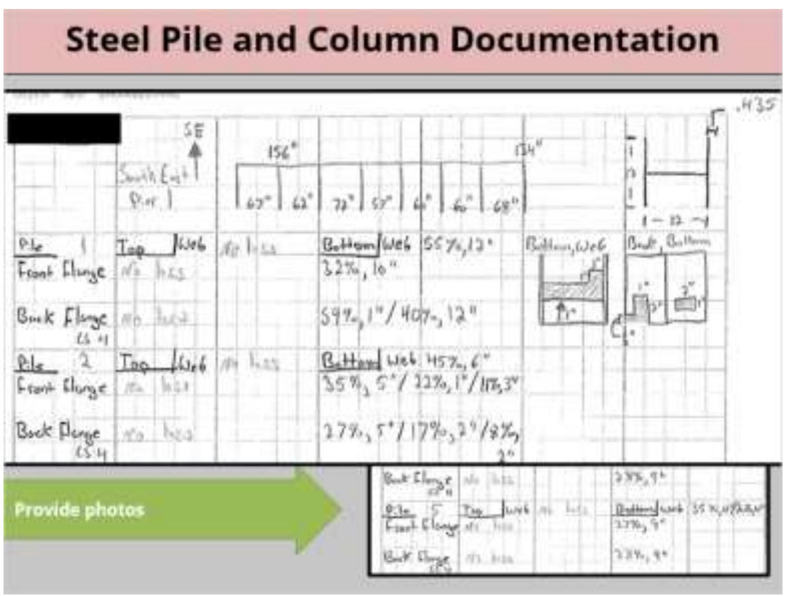

When section loss appears to be greater than 5 percent take measurements to determine the actual amount of section loss. When section loss is measured to be greater than 15 percent per element a sketch is required. This sketch should include percent section loss at each location on the element including the size and location of voids.

Section loss is not defined by a localized area but as the section loss of an entire member by cross-sectional area. In the sketch shown, the voids are in addition to the percent section loss. The measurements were taken at each end of the flanges and the average was recorded for each. Also provided is the distance from the bottom or top of pile. It is important to note, when section loss is greater than 15% per pile or column the element falls into the corrosion defect of condition state 4. Sketch of measured section loss must be uploaded into HSI under the current inspection. Gathering good data for the reviewer is important especially if analysis is warranted. In addition to a section loss sketch it is important to upload representative photos into HSI () of the corrosion present for these elements.

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Wingwalls that are not integral or not poured monolithic with the concrete abutment body must be evaluated under the correct retaining wall element. Timber and Steel wingwalls are considered integral even with the presence of a joint at the end of the abutment on flared wingwalls. R-numbered structures (retaining walls) are not wingwalls, therefore they must not be coded as part of the bridge inspection. On the other hand it is highly recommended they be noted in the structure specific notes within the inspection report.

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Integral wingwalls begin either at the edge of superstructure, face of backwall or the edge of abutment prominence, if present. For the example shown, the abutment is a sill abutment with an integral concrete wing attached with no joint between the two.

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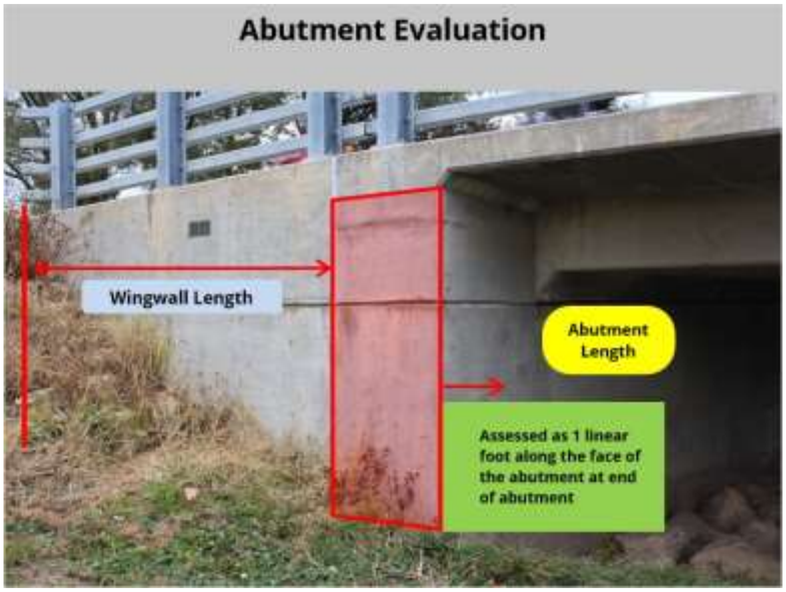

The abutment end shown in the red rectangle above, should be assessed as 1 linear foot along the face of the abutment at each end of abutment, regardless of actual thickness of the abutment.

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All web walls and most crash walls attached to a pier shall be assessed 20' from exterior columns and coded under (Assessment 9250)
The quantity is 1 each per substructure unit.

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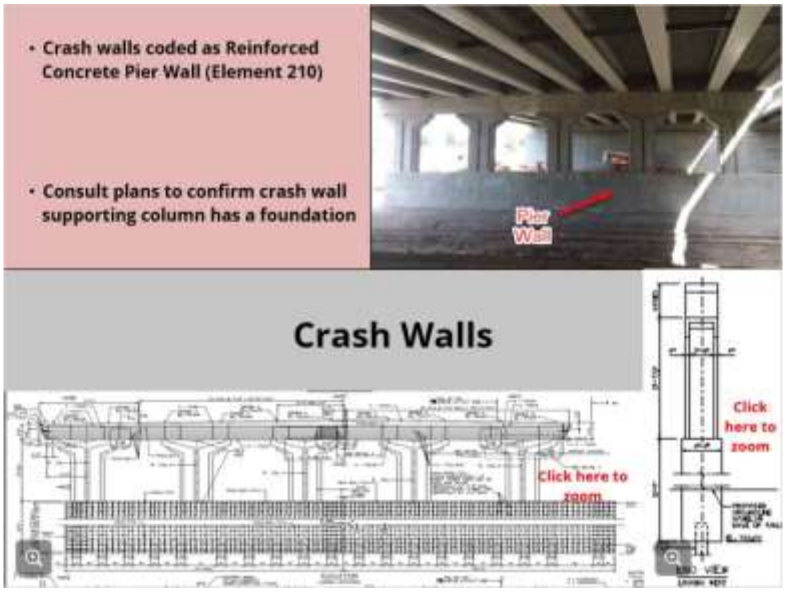

The exception is when a crash wall also acts as a pier wall, supporting the vertical load from the pier columns with a full-length foundation. In these instances, code as Pier Wall (210). Element 210 Reinforced Concrete pier wall sometimes acts as a crash wall, supporting the vertical load from the pier columns with a full-length foundation as seen in the picture. Consult the as-built plans if available to help decide if it is visually unclear. If plans are not available and visually it looks like the crash wall is supporting the pier columns, please code it as element 210.

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