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DECKS AND SLABS

2.2.1 Introduction

Decks are structural components of a bridge, and they serve several functions. First, they provide a smooth riding surface for traffic crossing the bridge. Second, they distribute the bridge live loads (such as vehicle wheel loads) laterally to the girders, stringers, and floor beams. Third, reinforced concrete decks may also function as part of the top flange of steel open girder, steel box girder, prestressed concrete and concrete box girder bridges. They always serve as the top flange of reinforced concrete T-beam bridges.

Decks receive a considerable amount of abuse from sources such as wheels, snow plow blades, and road debris that cause wear and abrasion; truck overloads that can cause overstress within the deck material; deicing chemicals that cause corrosion; freeze/thaw weathering effects that can cause material breakdown; and parasites/fungi that cause biological material deterioration. To protect the deck from these sources of deterioration, wearing surfaces, such as overlays or running boards, are often placed on top.

Decks should not be confused with slab bridges. Decks are elements separate from the superstructure. They are placed on top of girders, stringers or floor beams, typically spanning laterally between these superstructure elements. Slabs do not bear on separate superstructure elements. Slabs are superstructures themselves, spanning longitudinally from substructure unit to substructure unit.

The slab acts as a single, wide beam spanning from substructure unit to substructure unit. There are no individual beams with this type of bridge, and the slab also acts as the deck. Slabs are used for simple spans of about 45 feet or less. Continuous slab bridges can be built with slightly longer span lengths. To attain greater negative bending strength on continuous bridges, the slab may be thickened (haunched) over the piers. The main reinforcing steel is placed parallel to traffic and located towards the bottom of the slab in positive bending regions, and towards the top of the slab in negative bending regions. On older and more complex structures, continuous cast-in-place slabs may contain voids to lighten the dead load of the bridge.

Slabs represent the simplest superstructures and have been in use for many years. Concrete slab elements are currently the most economical method to span short distances. Slab elements are most commonly constructed using cast-in-place methods, although plant fabricated precast/prestressed or post-tensioned hollow core planks have also been used to create slab bridges. Precast slabs are different than precast box beams in that precast slabs contain two or more voids through them, while box beams have only one. Precast slab may also be designed solid, with no voids in them.

Slabs are most commonly comprised of concrete, although timber slabs do exist. These elements are typically deeper dimension lumber post-tensioned together transversely with rods. Other materials may also be used so long as they are capable of carrying Wisconsin legal loads.

2.2.2 Reinforced Concrete Elements

Concrete decks and slabs are by far the most common type an inspector will encounter. They may or may not be covered with an overlay.

2.2.2.1 Reinforced Concrete Deck (Element 12)
Reinforced Concrete Slab (Element 38)

Element Level Inspection

These elements define all reinforced concrete bridge decks and slabs regardless of the wearing surface or protective systems used. Deck and slab elements shall be used to evaluate only the edge and bottom surfaces of the respective element. Per WisDOT policy, the top surface of all deck and slab elements (excluding the Steel Deck – Open Grid element) will be evaluated using an associated wearing surface element. Those deck, slab or top flange elements without an overlay or other type of wearing surface will have the top surface evaluated under element Wearing Surface – Bare (Element 8000). Timber planks used along running wheel lines shall be included under the wearing surface Element 510 – Wearing Surface (Other). Refer to Chapter 6 of Part 2 for more information on Wearing Surface elements and their associated material defects.

Concrete overlays are sometimes difficult to distinguish from the bare structural concrete deck. Therefore, the inspector should make it a habit to review the Construction History on the Element Level Inspection form. The Construction History should list any overlays that were added as well as the year the overlay was constructed. Likewise, if an inspector realizes that an overlay was added to a bridge but the Construction History does not reflect the change, the inspector shall make note of the overlay in the Construction History, update the overburden data, and check the rerate flag.

Due to the possible presence of an overlay (top), structural deck (integral structural concrete overlay) or stay-in-place forms (bottom), deck top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing, or indicators in the materials covering the surfaces.

By today’s engineering practices, concrete decks and slabs in Wisconsin are constructed with epoxy coated reinforcing or stainless steel reinforcement to help protect the reinforcing steel nearest the riding surface from the corrosive effects of deicing chemicals. However, in the past not all bridges were constructed with these types of reinforcing bars. The deck element will note the type of protective coating (if any) on deck and slab reinforcing. The inspector is responsible for reporting this data, and the inspector will be able to update the element data where he/she is aware of reinforcing bars utilized within the deck or slab element. Refer to the Concrete Reinforcing Steel Protective Systems section in Chapter 6 Part 2 for more information.

Sometimes the inspector will encounter a deck with two configurations. A common example of this occurs on bascule bridges, where the approach spans often have concrete decks (with or without an overlay) and the movable span has a steel grid deck. For this situation, two deck elements are required to be entered on the inspection form, with the square footage distributed appropriately between the elements and broken out into each Condition State as necessary.

On the inspection report form, reinforced concrete deck or slab is recorded in units of “square feet”. The correct method for calculating the deck or slab area is to multiply the structure length by the edge to edge width including any median areas and accounting for any flares or ramps present. The overhangs located under parapets and sidewalks are included in the deck or slab measurement. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element’s condition and help generate quantity/cost estimates for future remedial work.

The deck or slab evaluation is three dimensional in nature with the defects observed on the bottom surface and edges, and being captured using the defined defects. This quantifies the element’s condition which is used to track the progression of material degradation and generate quantity/cost estimates for future remedial work.

Problems on deck or slab elements the inspector should look for include:

- Transverse flexural cracks adjacent to and over piers. These are caused by superstructure negative bending.
- Diagonal or transverse temperature/shrinkage cracks. Diagonal cracks are typically located on the corners of skewed decks or slabs.
- Longitudinal flexural cracks caused by deck positive bending between the girders or stringers. Wide cracks may indicate a serious structural overload. Note the maximum crack widths measured on the bridge inspection report.
- Efflorescence, discoloration, and rust staining which will often accompany cracks.
- Indications of corroding reinforcing steel such as rust stains or exposed reinforcement. Since section loss associated with reinforcing steel corrosion can reduce the deck or slab’s strength, measure this loss if possible and record it.
- Delaminations, spalls, and exposed/corroded reinforcing steel. Deteriorated concrete in the flexural zones may cause debonding of the reinforcing steel.
- Loose or spalling concrete located over a traveled way such as a roadway, train track, river, or pedestrian path. These can fall and cause damage or injury. Such loose concrete should be reported and recommended for removal by a maintenance crew if it cannot be safely done during the inspection.
- Cracks, delaminations, spalls, and exposed reinforcing steel located under drains or leaking expansion joints.
- Punching shear failures. Although they are rare, punching failures will show up as a localized area of radial-shaped cracks with the deck bulged downward.

Figure 2.3.2.1-1: Reinforced Concrete Slab w/ Spalling and Exposed Corroded Reinforcing - Condition State 3.

When the inspector is evaluating the bottom of the deck, it is important to assess the amount of deterioration as it is a valuable window used to assess the structural condition of the interior and top of deck. The amount of deterioration on the underside is a good indication of how much moisture is passing through the element.

Temperature and shrinkage cracks are common and will be found on most every concrete deck or slab. However, many types of cracks are more indicative of a structural issue. All types of cracking must be accounted for and a portion of the total quantity must be assigned to a Condition State. Types of cracks commonly encountered include the following:

- Temperature and shrinkage cracks (non-structural). These will be apparent on most concrete decks. These types of cracks almost always show up at the acute corners of skewed decks.

- Transverse flexural cracks (structural) due to negative bending will most likely appear over the piers of continuous superstructures.

- Transverse reflective cracks (non-structural) may appear at closely spaced, regular intervals on plank decks with asphalt overlays. These are caused by differential plank deflections.

- Transverse reflective cracks (non-structural) may appear adjacent to an expansion joint. These cracks suggest that the joint anchorage hardware is beginning to fail.

- Longitudinal flexural cracks (structural). These are caused by negative bending of the deck over the girders or beams.

- Longitudinal reflective cracks (non-structural) may appear along the joints of prestressed concrete channels or box beams placed tight, side by side. This cracking is caused by differential beam deflection.

- Longitudinal construction joints in overlays (non-structural).

Figure 2.3.2.1-2: Cracking of Concrete Deck (Localized Area Over Pier) – Condition State 2.

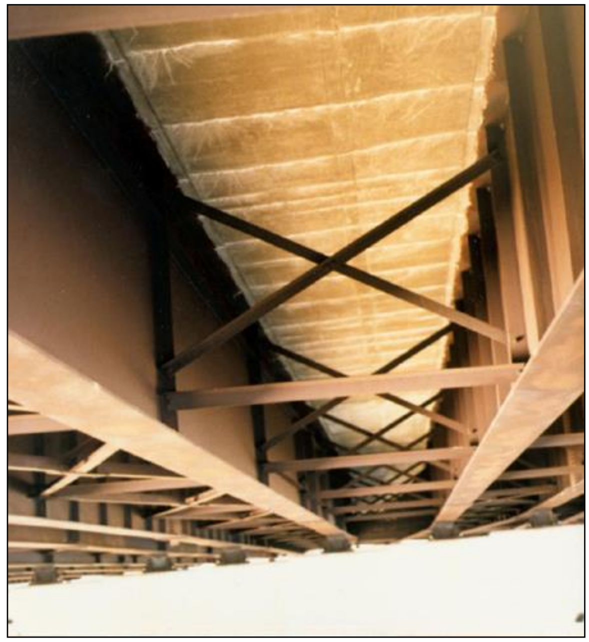

Figure 2.3.2.1-3: Heavy Density Cracking of Concrete Deck w/ Efflorescence – Condition State 3.

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects. However, only the controlling defect will be counted in the total element condition state quantity.

- Delamination/ Spall/ Patched Area (1080)
- Exposed Rebar (1090)
- Cracking (RC and Other) (1130)
- Abrasion/Wear (PSC/RC) (1190)
- Chloride Concentration (8905)
- Precast Concrete Connections (8906)

Condition State Commentary

The Condition States for describe repaired areas. Repaired areas are considered “distressed” if the repair is a short-term maintenance action that does not restore the deck’s structural integrity (such as filling potholes with asphalt). Therefore these repairs do not improve the Condition State rating of an element. Repaired areas are considered "rehabilitations" if the repair (such as full or partial depth concrete patches) improves the deck's structural integrity, thereby improving the rating after work has been completed.

Figure 2.3.2.1-4: Typical Reinforced Concrete Slab Distress.

The inspector is responsible to carry all necessary equipment to make accurate measurements if necessary. Concrete Condition States are dependent on crack width and spall dimensions and depth.

The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

2.2.2.2 Reinforced Concrete Top Flange (Element 16)

There are several concrete structures that have concrete superstructures whose top components act as the deck of the structure. In these structures the deck is composite with the girder and acts as the compression flange of girder as well as potentially the wearing surface for vehicles. The following structures are common reinforced concrete superstructures with monolithic top flanges.

1. **Tee beams:** Tee beam bridges were commonly constructed in the early half of the 20th century. They are cast-in-place structures, with the deck cast monolithic with the beams. The "tee" shape is created by the rectangular beam stem below the deck, with the deck forming the top flange. In Wisconsin, the fascia beams on some tee beam bridges are upturned, doubling as parapets. Tee beam bridges are most commonly used for simple spans, although they may be made continuous by haunching the beam stems over the piers. Individual spans may reach 50 feet in length, with the beams spaced from about 3 to 8 feet. Common beam depths range from 18 to 24 inches. The main reinforcing steel is placed longitudinally towards the bottom of the beam in positive bending regions and longitudinally within the deck in negative bending regions. Transverse, vertical stirrups placed along the beams serve as shear reinforcing.

   Historically Wisconsin has evaluated tee beams utilizing the elements reinforced concrete deck and reinforced concrete open girder/beam and continues to utilize this convention over the use of reinforced concrete top flange.

2. **Through girders:** Through girder bridges were constructed in the early half of the 20th century. They are cast-in-place structures, with the deck cast monolithic with the girders. Two girders normally are used, and these very deep girders serve as the bridge parapets. The deck spans between the girders, connected to the lower portion of the girders. Through girder bridges are used for simple spans of 30 to 60 feet. Because the deck must span between the girders, through girder bridge widths rarely exceed 24 feet. The girders themselves are fairly large, being 18 to 30 inches wide and 4 to 6 feet deep. The main reinforcing steel is placed longitudinally towards the bottom of the girders, while the main deck reinforcing steel is placed transversely towards the deck bottom. Transverse, vertical stirrups placed along the girders serve as shear reinforcing.

Figure 2.3.2.2-1: Reinforced Concrete through Girder Bridge.

3. **Channel beams:** Channel beam bridges use precast channel beams as the primary load-carrying members. The channels are placed on the substructure units so that they form an upside down "U", with the vertical legs forming the beams and the horizontal top slab forms the deck. The channels are placed tight side by side and maybe transversely connected so that the individual beams act as a unit under live loads. Grouted shear keys may also have been utilized to help the beams act together. Channel beam bridges are used for simple spans up to about 50 feet. Widths of the individual beams usually range from 3 to 4 feet. The main reinforcing steel is placed longitudinally towards the bottom of the channel legs, while the main deck reinforcing steel is placed transversely in the top slab. Vertical stirrups may be placed along the channel legs and serve as shear reinforcing.

Please refer to Chapter 4 Superstructures, for additional information concerning these bridges. The element discussed in this section deals only with the top flange portion of these superstructures where traffic rides directly on the structural element.

Element Level Inspection

This element shall be used for all reinforced concrete bridge girder top flanges where traffic rides directly on the structural element regardless of the wearing surface or protection systems used. Top flange elements shall be used to evaluate only the edge and bottom surfaces of the respective element. Top Flange elements are considered deck elements. Per WisDOT policy, the top surface of all deck and slab elements (excluding the Steel Deck – Open Grid element) will be evaluated using an associated wearing surface element. Those deck, slab or top flange elements without an overlay or other type of wearing surface will have the top surface evaluated under element Wearing Surface – Bare (Element 8000). Refer to Chapter 6 of Part 2 for more information on Wearing Surface elements and their associated material defects.

Wearing Surfaces (including overlays) are separate elements from reinforced concrete top flanges. Thin overlays are defined as being less than 1-inch in thickness, and may be materials such as Portland cement, epoxies or other polymers. It is important for the inspector to keep in mind that overlays do not increase the structural capacity of the deck. In fact, overlays slightly reduce the structural capacity due to the increased dead load (overburden).

The inspector should always review the *Construction History* on the backside of the Element Level Inspection form. The *Construction History* should list any overlays that were added as well as the year the overlay was constructed. Likewise, if an inspector realizes that an overlay was added to a bridge but the *Construction History* does not reflect the change, the inspector shall make note of the overlay in the *Construction History*, update the overburden data, and check the rerate flag.

On the inspection report form, reinforced concrete top flange is recorded in units of “square feet”. The correct method for calculating the flange area is to multiply the structure length by the edge to edge width including any median areas and accounting for any flares or ramps present. The overhangs (not monolithic with the top flange) located under parapets and sidewalks are not included in the flange width measurement. This quantity is for the flange only, all girder components (web, bottom flange, etc.) should be quantified under the appropriate superstructure element. Please refer to Chapter 4 of Part 2 for Superstructure Elements.

The top flange evaluation is three dimensional in nature with the defects observed on the bottom surface and edges, and being captured using the defined defects. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element’s condition and help generate quantity/cost estimates for future remedial work.

By today’s engineering practices, concrete decks and slabs in Wisconsin are constructed with epoxy coated reinforcing to protect the reinforcing steel nearest the riding surface from deicing chemicals. However, in the past not all bridges were constructed with epoxy coated bars. The inspection report form will note the type of coating on deck and slab reinforcing. The inspector will not be responsible for reporting this element, although the inspector will be able to add the element if he/she is aware of coated bars within the deck or slab element. Refer to the Concrete Reinforcing Steel Protective Systems section in Chapter 6 Part 2 for more information.

When the inspector is evaluating the bottom of the flange, it is important to assess the amount of deterioration as it is a valuable window used to assess the structural condition of the interior and top of the flange element. The amount of deterioration on the underside is a good indication of how much moisture is passing through the element.

If stay-in-place forms (bottom) prevent the inspector from viewing the bottom surfaces, those surfaces shall be assessed and evaluated based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

Problems on the top flange element the inspector should look for include:

- Transverse flexural cracks adjacent to and over piers. These are caused by superstructure negative bending.

- Diagonal or transverse temperature/shrinkage cracks.

- Longitudinal flexural cracks caused by deck positive bending between the girders or stringers. Wide cracks may indicate a serious structural overload. Note the maximum crack widths measured on the bridge inspection report.

- Efflorescence, discoloration, and rust stains, which will often accompany cracks.

- Delaminations, spalls, and exposed/corroded reinforcing steel. Deteriorated concrete in the flexural zones may cause debonding of the reinforcing steel.

- Indications of corroding reinforcing steel, such as rust stains or exposed reinforcement. Since section loss associated with reinforcing steel corrosion can reduce the deck's strength, measure this loss if possible and record it.

- Loose or spalling concrete located over a traveled way such as a roadway, train track, river, or pedestrian path. These can fall and cause damage or injury. Such loose concrete should be reported and recommended for removal by a maintenance crew if it cannot be safely done during the inspection.

- Cracks, delaminations, spalls, and exposed reinforcing steel located under drains or leaking expansion joints.

- Punching shear failures. Although they are rare, punching failures will show up as a localized area of radial-shaped cracks with the deck bulged downward.

Figure 2.3.2.2-2: Reinforced Concrete Box Girder Top Flange/Deck Localized Rebar Corrosion and Bond Loss.

Temperature and shrinkage cracks are common and will be found on most every concrete surface. However, many types of cracks are more indicative of a structural issue. All types of cracking must be accounted for and a portion of the total quantity of the area must be assigned to a Condition State. Look on the top of the flange (deck side) for any cracking. Types of cracks commonly encountered include the following:

- Temperature and shrinkage cracks (non-structural). These will be apparent on most concrete surfaces. These types of cracks almost always show up at the acute corners of skewed decks.

- Transverse flexural cracks (structural) due to negative bending will most likely appear over the piers of continuous superstructures.

- Transverse reflective cracks (non-structural) may appear at closely spaced, regular intervals on plank decks with asphalt overlays. These are caused by differential plank deflections.

- Transverse reflective cracks (non-structural) may appear adjacent to an expansion joint. These cracks suggest that the joint anchorage hardware is beginning to fail.

- Longitudinal flexural cracks (structural). These are caused by negative bending of the deck over the girders or beams.

- Longitudinal reflective cracks (non-structural) may appear along the joints of prestressed concrete channels or box beams placed tight, side by side. This cracking is caused by differential beam deflection.

- Longitudinal construction joints in overlays (non-structural).

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects. However, only the controlling defect will be counted in the total element condition state quantity.

- Delamination/ Spall/ Patched Area (1080)
- Exposed Rebar (1090)
- Cracking (RC and Other) (1130)
- Abrasion/Wear (PSC/RC) (1190)
- Chloride Concentration (8905)
- Precast Concrete Connections (8906)

Condition State Commentary

The Condition States for describe repaired areas. Repaired areas are considered “distressed” if the repair is a short-term maintenance action that does not restore the deck’s structural integrity (such as filling potholes with asphalt). Therefore these repairs do not improve the Condition State rating of an element. Repaired areas are considered “rehabilitations” if the repair (such as full or partial depth concrete patches) improves the deck’s structural integrity, thereby improving the rating after work has been completed.

The inspector is responsible to carry all necessary equipment to make accurate measurements if necessary. Concrete Condition States are dependent on crack width and spall dimensions and depth.

The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

2.2.3 Prestressed Concrete Elements

Components are pre-cast away from the bridge site and either pretensioned prior to concrete placement or post-tensioned after the concrete has been placed and cured. This tensioning of the strands creates compressive forces in the concrete component which reduces the amount of tension cracking that would occur in a conventionally reinforced cast-in-place deck.

Another prestressed bridge deck component is the monolithic top flange of a prestressed girder which acts as a driving surface. A common example would be a tee-beam bridge. Similar to a slab, the flange and beam is one unit and act as both the deck and superstructure. These beams are prevalent in Accelerated Bridge Construction (ABC). Pre-cast prestressed concrete bridge components provide an owner with a faster alternative than time-consuming concrete curing of cast-in-place systems. The costs are greater, however, for the component materials, as well as the additional equipment needed for the panel installment.

Prestressed concrete slabs, similar to reinforced concrete slabs, comprise the deck and superstructure. There are no girders or monolithic legs below the slab. The slab element itself spans from one substructure unit to the next. Examples of prestressed concrete slabs include:

- **Solid core prestressed planks:** As a superstructure, these components would be set adjacent to one another with only a joint separating each plank. The planks are either grouted together along a joint on the driving surface or tensioned together transversely by post tensioning. By appearance, these would look very similar to box beams. The inspector will need to use the plans to determine the actual composition of the superstructure.

- **Inverted Tee Beams:** Similar to solid core planks, these beams are set adjacent to one another separated by only a joint. A cross-sectional view of the component explains the name as the beam appears like an upside-down T. The stem of the tee is much wider than most girders as it acts partly as the compression flange. The key formed between the webs of adjacent beams is filled with concrete and typically a reinforced concrete deck is cast over the top of the beams to add structural capacity and further tie the beams together.

- **Post Tensioned Cast-in-Place Slabs:** These superstructures are essentially reinforced concrete slabs only more shallow and constructed with post-tensioning ducts throughout to strengthen the slab after concrete placement. Verification through the bridge plans may be necessary by the inspector.

2.2.3.1 Prestressed Concrete Deck (Element 13)
Prestressed Concrete Slab (Element 8039)

These elements define all prestressed concrete bridge decks and slabs regardless of the wearing surface or protective systems used. The deck and slab evaluation is all inclusive with the defects observed on the bottom and edges of the element and being captured using the defined condition states. Per WisDOT policy, the top surface of all deck and slab elements (excluding the Steel Deck – Open Grid element) will be evaluated using an associated wearing surface element. Those deck, slab or top flange elements without an overlay or other type of wearing surface will have the top surface evaluated under element Wearing Surface – Bare (Element 8000). Refer to Chapter 6 of Part 2 for more information on Wearing Surface elements and their associated material defects.

Due to the possible presence of an overlay (top), structural deck (integral structural concrete overlay) or stay-in-place forms (bottom), deck top or bottom surfaces that are not visible for inspection shall be assessed based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

These decks are not to be mistaken for Prestressed Concrete Top Flange, which are integral prestressed decks and girders where the top flange acts as a deck as well as compression flange of the girder. Prestressed Concrete Decks are typically comprised of precast panels that lie transversely or longitudinally on the girders with a gap between. The gap is filled with concrete to create a composite superstructure. Panels may also be overlaid with concrete creating a jointless deck. This cast-in-place deck would still be considered part of the Prestressed Concrete Deck element.

Element Level Inspection

By today's engineering practices, concrete decks and slabs in Wisconsin are constructed with epoxy coated reinforcing to protect the reinforcing steel nearest the riding surface from deicing chemicals. However, in the past not all bridges were constructed with epoxy coated bars. The inspection report form will note the type of coating on deck and slab reinforcing. The inspector will not be responsible for reporting this element, although the inspector will be able to add the element if he/she is aware of coated bars within the deck or slab element. Refer to the Concrete Reinforcing Steel Protective Systems section in Chapter 6 Part 2 for more information.

Sometimes the inspector will encounter a deck with two configurations. A common example of this occurs on bascule bridges, where the approach spans often have concrete decks (with or without an overlay) and the movable span has a steel grid deck. For this situation, two deck elements are required to be entered on the inspection form, with the square footage distributed appropriately between the elements.

On the inspection report form, prestressed concrete decks or slabs are recorded in units of "square feet". The correct method for calculating the deck or slab area is to multiply the structure length by the edge to edge width including any median areas and accounting for any flares or ramps present. The overhangs located under parapets and sidewalks are included in the deck or slab measurement.

The deck or slab evaluation is three dimensional in nature with the defects observed on the bottom surface and edges, and being captured using the defined defects. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element's condition and help generate quantity/cost estimates for future remedial work.

When the inspector is evaluating the bottom of the flange, it is important to assess the amount of deterioration as it is a valuable window used to assess the structural condition of the interior and top of the flange element. The amount of deterioration on the underside is a good indication of how much moisture is passing through the element.

Problems on the element the inspector should look for include:

- Transverse flexural cracks adjacent to and over piers. These are caused by superstructure negative bending.
- Diagonal or transverse temperature/shrinkage cracks.
- Longitudinal flexural cracks caused by deck positive bending between the girders or stringers. Wide cracks may indicate a serious structural overload. Note the maximum crack widths measured on the bridge inspection report.
- Efflorescence, discoloration, and rust staining which will often accompany cracks.
- Delaminations, spalls, and exposed/corroded reinforcing steel. Deteriorated concrete in the flexural zones may cause debonding of the reinforcing steel.
- Indications of corroding reinforcing steel such as rust stains or exposed reinforcement. Since section loss associated with reinforcing steel corrosion can reduce the deck's strength, measure this loss if possible and record it.
- Loose or spalling concrete located over a traveled way such as a roadway, train track, river, or pedestrian path. These can fall and cause damage or injury. Such loose concrete should be reported and recommended for removal by a maintenance crew if it cannot be safely done during the inspection.
- Cracks, delaminations, spalls, and exposed reinforcing steel located under drains or leaking expansion joints.
- Punching shear failures. Although they are rare, punching failures will show up as a localized area of radial-shaped cracks with the deck bulged downward.

On the report, the inspector should describe cracks in terms of their location, orientation, length, and maximum width. Indicate also if the cracks are structural or nonstructural.

Temperature and shrinkage cracks are common and will be found on most every concrete deck or slab. However, many types of cracks are more indicative of a structural issue. All types of cracking must be accounted for and a portion of the total quantity of area assigned to a Condition State. Look on the top of the deck for any cracking. Types of cracks commonly encountered include the following:

- Temperature and shrinkage cracks (non-structural). These will be apparent on most concrete decks and overlays. These types of cracks almost always show up at the acute corners of skewed decks.
- Transverse flexural cracks (structural) due to negative bending will most likely appear over the piers of continuous superstructures.
- Transverse reflective cracks (non-structural) may appear at closely spaced, regular intervals on plank decks with asphalt overlays. These are caused by differential plank deflections.
- Transverse reflective cracks (non-structural) may appear adjacent to an expansion joint. These cracks suggest that the joint anchorage hardware is beginning to fail.
- Longitudinal flexural cracks (structural). These are caused by negative bending of the deck over the girders or beams.
- Longitudinal reflective cracks (non-structural) may appear along the joints of prestressed concrete channels or box beams placed tight, side by side. This cracking is caused by differential beam deflection.
- Longitudinal construction joints in overlays (non-structural).

Maintenance inspection of concrete decks with asphaltic concrete overlays should include the following items:

- Examining the top of the deck, looking for potholes, and impending potholes. Impending potholes usually show up as radial cracks, localized map cracks, or depressions in the overlay.
- Looking for overlay repairs in the form of potholes filled with asphalt.
- Checking to see if potholes expose the concrete deck. If so, the deck should be examined to determine its condition and any problems should be reported.
- Looking for overlay cracks, which may allow water to reach the structural concrete deck below. Many times, cracks exist at the panel joints. The inspector should also look for transverse or D-cracks adjacent to expansion joints, as this situation indicates anchorage loosening or failure of the expansion joint armor. Older overlays may contain random or map cracking. These cracks may have been routed and filled with tar, blocking water movement to the deck.

Cracking not appearing to be temperature or shrinkage cracking is a significant cause of concern for any prestressed elements. Prestressing concrete is intended to keep the element in compression even under legal loading. A crack larger than hairline may be an indication of overloading. Inspectors should take care to detect and note any structural cracking in prestressed elements.

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects. However, only the controlling defect will be counted in the total element condition state quantity.

- Delamination/ Spall/ Patched Area (1080)
- Exposed Prestressing (1100)
- Cracking (Prestressed concrete) (1110)
- Abrasion/Wear (PSC/RC) (1190)
- Chloride Concentration (8905)
- Precast Concrete Connections (8906)

Condition State Commentary

The Condition States for describe repaired areas. Repaired areas are considered “distressed” if the repair is a short-term maintenance action that does not restore the deck’s structural integrity (such as filling potholes with asphalt). Therefore these repairs do not improve the Condition State rating of an element. Repaired areas are considered “rehabilitations” if the repair (such as full or partial depth concrete patches) improves the deck’s structural integrity, thereby improving the rating after work has been completed.

The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

2.2.3.2 Prestressed Concrete Top Flange (Element 15)

There are several prestressed concrete girders whose top flanges act as the deck of the structure. In these structures the top flange is composite with the girder and acts as the compression flange of the girder as well as the wearing surface for traffic. These structures include:

- Tee beams
- Through girders
- Channel beams
- Prestressed box beams
- Box girders
- Segmental box girders

Please refer to Chapter 4 Superstructures, for additional information concerning these bridges. The element discussed in this section deals only with the top flange portion of these superstructures where traffic rides directly on the structural element. The element is assessed regardless of the wearing surface if one is present.

Element Level Inspection

This element shall be used for all prestressed concrete bridge girder top flanges where traffic rides directly on the structural element regardless of the wearing surface or protection systems used. Top flange elements shall be used to evaluate only the edge and bottom surfaces of the respective element. Top Flange elements are considered deck elements. Per WisDOT policy, the top surface of all deck and slab elements (excluding the Steel Deck – Open Grid element) will be evaluated using an associated wearing surface element. Those deck, slab or top flange elements without an overlay or other type of wearing surface will have the top surface evaluated under element Wearing Surface – Bare (Element 8000). Refer to Chapter 6 of Part 2 for more information on Wearing Surface elements and their associated material defects.

Wearing Surfaces (including overlays) are separate elements from reinforced concrete top flanges. Thin overlays are defined as being less than 1-inch in thickness, and may be materials such as Portland cement, epoxies or other polymers. It is important for the inspector to keep in mind that overlays do not increase the structural capacity of the deck. In fact, overlays slightly reduce the structural capacity due to the increased dead load (overburden).

The inspector should always review the *Construction History* on the backside of the Element Level Inspection form. The *Construction History* should list any overlays that were added as well as the year the overlay was constructed. Likewise, if an inspector realizes that an overlay was added to a bridge but the *Construction History* does not reflect the change, the inspector shall make note of the overlay in the *Construction History*, update the overburden data, and check the rerate flag.

On the inspection report form, prestressed concrete top flange is recorded in units of “square feet”. The correct method for calculating the flange area is to multiply the structure length by the edge to edge width including any median areas and accounting for any flares or ramps present. The overhangs (not monolithic with the top flange) located under parapets and sidewalks are not included in the flange width measurement. This quantity is for the flange only, all girder components (web, bottom flange, etc.) should be quantified under the appropriate superstructure element. Please refer to Chapter 4 of Part 2 for Superstructure Elements.

The top flange evaluation is three dimensional in nature with the defects observed on the bottom surface and edges, and being captured using the defined defects. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element’s condition and help generate quantity/cost estimates for future remedial work.

By today’s engineering practices, concrete decks and slabs in Wisconsin are constructed with epoxy coated reinforcing to protect the reinforcing steel nearest the riding surface from deicing chemicals. However, in the past not all bridges were constructed with epoxy coated bars. The inspection report form will note the type of coating on deck and slab reinforcing. The inspector will not be responsible for reporting this element, although the inspector will be able to add the element if he/she is aware of coated bars within the deck or slab element. Refer to the Concrete Reinforcing Steel Protective Systems section in Chapter 6 Part 2 for more information.

When the inspector is evaluating the bottom of the flange, it is important to assess the amount of deterioration as it is a valuable window used to assess the structural condition of the interior and top of the flange element. The amount of deterioration on the underside is a good indication of how much moisture is passing through the element.

If stay-in-place forms (bottom) prevent the inspector from viewing the bottom surfaces, those surfaces shall be assessed and evaluated based on the available visible surface. If both top and bottom surfaces are not visible, the condition shall be assessed based on destructive and nondestructive testing or indicators in the materials covering the surfaces.

Problems on the element that the inspector should look for include:

- Transverse flexural cracks adjacent to and over piers. These are caused by superstructure negative bending.
- Diagonal or transverse temperature/shrinkage cracks.
- Longitudinal flexural cracks caused by deck positive bending between the girders or stringers. Wide cracks may indicate a serious structural overload. Note the maximum crack widths measured on the bridge inspection report.
- Diagonal or transverse temperature/shrinkage cracks.
- Efflorescence, discoloration, and rust stains which will often accompany cracks.

- Delaminations, spalls, and exposed/corroded reinforcing steel. Deteriorated concrete in the flexural zones may cause debonding of the reinforcing steel.

- Signs of corroding reinforcing steel such as rust stains or exposed reinforcement. Since section loss associated with reinforcing steel corrosion can reduce the deck's strength, measure this loss if possible and record it.

- Loose or spalling concrete located over a traveled way such as a roadway, train track, river, or pedestrian path. These can fall and cause damage or injury. Such loose concrete should be reported and recommended for removal by a maintenance crew if it cannot be safely done during the inspection.

- Cracks, delaminations, spalls, and exposed reinforcing steel located under drains or leaking expansion joints.

- Punching shear failures. Although they are rare, punching failures will show up as a localized area of radial-shaped cracks with the deck bulged downward.

On the report, the inspector should describe cracks in terms of their location, orientation, length, and maximum width. Indicate also if the cracks are structural or nonstructural.

Temperature and shrinkage cracks are common and will be found on most every concrete surface. However, many types of cracks are more indicative of a structural issue. All types of cracking must be accounted for and a portion of the total quantity of area assigned to a Condition State. Look on the top and underside of the flange for any cracking. Types of cracks commonly encountered include the following:

- Temperature and shrinkage cracks (non-structural). These will be apparent on most concrete decks and overlays. These types of cracks almost always show up at the acute corners of skewed decks.

- Transverse flexural cracks (structural) due to negative bending will most likely appear over the piers of continuous superstructures.

- Transverse reflective cracks (non-structural) may appear at closely spaced, regular intervals on plank decks with asphalt overlays. These are caused by differential plank deflections.

- Transverse reflective cracks (non-structural) may appear adjacent to an expansion joint. These cracks suggest that the joint anchorage hardware is beginning to fail.

- Longitudinal flexural cracks (structural). These are caused by negative bending of the deck over the girders or beams.

- Longitudinal reflective cracks (non-structural) may appear along the joints of prestressed concrete channels or box beams placed tight, side by side. This cracking is caused by differential beam deflection.

- Longitudinal construction joints in overlays (non-structural).

Maintenance inspection of concrete decks with asphaltic concrete overlays should include the following items:

- Examining the top of the deck, looking for potholes, and impending potholes. Impending potholes usually show up as radial cracks, localized map cracks, or depressions in the overlay.
- Looking for overlay repairs in the form of potholes filled with asphalt.
- Checking to see if potholes expose the concrete deck. If so, the deck should be examined to determine its condition and any problems should be reported.
- Looking for overlay cracks, which may allow water to reach the structural concrete deck below. Many times, cracks exist at the panel joints. The inspector should also look for transverse or D-cracks adjacent to expansion joints, as this situation indicates anchorage loosening or failure of the expansion joint armor. Older overlays may contain random or map cracking. These cracks may have been routed and filled with tar, blocking water movement to the deck.

Figure 2.3.3.2-1: Localized Spall with Exposed/Corroding Rebar on the Deck Underside of a Post-Tensioned Box Girder.

Cracking not appearing to be temperature or shrinkage cracking is a significant cause of concern for any prestressed elements. Prestressing concrete is intended to keep the element in compression even under legal loading. A crack larger than hairline may be an indication of overloading. Inspectors should take care to detect and note any structural cracking in prestressed elements.

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects.

However, only the controlling defect will be counted in the total element condition state quantity.

- Delamination/ Spall/ Patched Area (1080)
- Exposed Prestressing (1100)
- Cracking (Prestressed concrete) (1110)
- Abrasion/Wear (PSC/RC) (1190)
- Chloride Concentration (8905)
- Precast Concrete Connections (8906)

Condition State Commentary

The Condition States describe repaired areas. Repaired areas are considered “distressed” if the repair is a short-term maintenance action that does not restore the deck’s structural integrity (such as filling potholes with asphalt). Therefore these repairs do not improve the Condition State rating of an element. Repaired areas are considered “rehabilitations” if the repair (such as full or partial depth concrete patches) improves the deck’s structural integrity, thereby improving the rating after work has been completed.

The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

2.2.4 Steel Elements

Steel decks are sometimes used on bridges because of their much lighter self weight versus concrete decks. They are often used on movable bridges to reduce the required counterweight needed to balance the span. Steel decks have also been used to replace concrete decks on older bridges when an increased live load capacity is desired, or when existing superstructure or substructure elements do not have enough strength to support the heavier dead load of a concrete deck replacement.

There are several types of steel decks:

1. **Grid decks:** These are the most common types of steel decks found in Wisconsin. Conventional steel grids are distinctive for the humming sound they make when traffic drives over them. Grid decks contain several components that are either welded or riveted together. These components include bearing bars, cross bars, and supplementary bars. Openings between these bars may be filled with concrete to improve a steel grid deck’s durability.

2. **Corrugated steel flooring:** This deck type uses corrugated steel plates transversely spanning between the girders or stringers. Corrugating steel plate vastly increases its strength and stiffness. The corrugations are smaller than stay-in-place forms, however the plating is thicker, ranging from 0.1 inch to 0.18 inch. After the flooring is fastened to the superstructure, the corrugations are filled with asphalt, concrete or gravel. Reinforcing is not found in this deck type. A problem with this type of deck system is that the flooring can trap and hold water that passes through the topping, making it very susceptible to corrosion. The corrosion often cannot be seen during an inspection because the plate surface experiencing the deterioration is hidden from view. Corrugated steel flooring is not normally used in Wisconsin.

3. **Buckle plate deck:** This is an obsolete style of deck once used on girder/floor beam/stringer floor systems. Buckle plates are dished downward in the middle and fastened on all four sides to the floor system. Reinforced concrete is then placed on top. Drain holes are normally provided in the middle of each plate.

4. **Orthotropic deck:** These decks are an advanced patented deck system often used on long span bridges for their light weight. Orthotropic decks act integrally with the superstructure primary members, reducing the total bridge dead load. An orthotropic deck consists of a flat steel plate with longitudinal stiffeners welded to the plate underside. The floor beams act to stiffen the deck in the transverse direction.

5. **Exodermic Deck:** These decks are a newer type of steel decking system in which a reinforced concrete slab is placed in a steel grid which is tied to a system of inverted steel tee beams. The concrete deck is composite with the lower steel beams through the steel grid. The concrete portion of the deck is designed to take the compressive forces while the steel takes the tensile forces. The concrete also protects the steel grid from environmental factors. These decks are lighter weight than reinforced concrete decks and can be precast to facilitate accelerated bridge construction.

2.2.4.1 Steel Deck – Open Grid (Element 28)

This element defines all open grid steel bridge decks with no fill. Open grid steel decks have high strengths. They are also light in weight because concrete is not used to fill the openings of the grid. Open grids are prefabricated using rectangular bars and delivered to the bridge site in several panels, which are then connected to the superstructure. The tops of the bars may be serrated to provide a skid-resistant riding surface.

Welded grid steel decks normally consist of bearing bars (also called primary or main bars). These are the main load carrying elements of a grid system. They span perpendicular between the stringers or girders and are fastened by welding. Cross bars (also called secondary or distribution bars) run parallel to the bridge. They are placed perpendicular to and on top of the bearing bars. Supplementary bars (also called tertiary bars) may or may not be found on a welded grid steel deck. They run parallel to the bearing bars, but are placed at the same level as the cross bars.

Several types of riveted grid steel decks may be encountered. Some use of bearing bars, cross bars, supplementary bars, and diagonal bars that span between the cross/supplementary bar intersections. Another type consists of main bars and crimp bars. Crimp bars are actually a length of narrow corrugated steel plate placed between the main bars. One edge of crimp bar is positioned at the same level as the top of the main bars. The crimp bar “zigzags” between the main bars, and is riveted at the point where the two bars make contact.

In recent years, the industry has begun to move away with welding and riveting fasteners. Instead the slotted hole connections are used. The holes are cut into the bearing bars and the distribution bars are placed through, rotated and locked into place by a key system.

Although they offer the advantage of a very light deck, open grid decks are constantly exposed to the elements. Even though they are often galvanized (and may even be painted), traffic wear quickly exposes the deck top surface. This leaves the deck vulnerable to corrosion. Open grids also leave the superstructure exposed to roadway debris, rain, and deicing chemicals. This can especially be a problem for movable bearings, which can lock up from pack rust and debris accumulation.

Figure 2.3.4.1-1: Open Grid Steel Deck.

Element Level Inspection

This element is for all open grid steel bridge decks with no fill.

On the inspection report form, Steel Deck – Open Grid is recorded in units of “square feet”. The correct method for calculating the deck area is to multiply the structure length by the edge to edge width including any median areas and accounting for any flares or ramps present. Overhangs located under parapets and sidewalks not comprised of open grid are not included in the deck measurement.

The steel deck – open grid evaluation is three dimensional in nature with the defects observed on the top surface, bottom surface and edges, and being captured using the defined defects. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element’s condition and help generate quantity/cost estimates for future remedial work.

For most circumstances, the entire deck will be assigned to only one element. Sometimes the inspector will encounter a deck with two or more configurations. This may be found on movable bridges, as it is not uncommon for a movable span to have open grid, filled grid, and concrete deck on various portions of the span.

In the unique situations when the steel grid has concrete in the wheel lines only, the area of filled deck should be coded under Element 29 – Steel Deck with Concrete Filled Grid. Multiple deck elements may be required to be entered on the inspection form, with the square footage distributed appropriately among the elements.

Maintenance inspection of open grid steel decks should include the following items:

- Examining the bearing bars in the bearing areas at stringers/girders for cracked welds or broken fasteners. Special attention should be paid at the tension areas of the bars.
- Looking for twisted, cracked, broken, or missing bars.
- Checking for corrosion and related section loss. A caliper is useful to measure the remaining section.
- Looking for worn serrations or excessive wear causing section loss. Worn serrations are very slippery, especially in wet weather.
- Listening for any rattling as traffic passes over the deck. Rattling suggests loose, broken, or missing fasteners.
- Looking for broken fasteners on riveted steel grid decks.
- Checking any repair plates placed over the grid to make sure they are still securely fastened. Repair plates tend not to be very durable.

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects. However, only the controlling defect will be counted in the total element condition state quantity.

- Corrosion (1000)
- Cracking (1010)
- Connection (1020)
- Distortion (1900)

Condition State Commentary

The inspector is responsible to carry all necessary equipment to make accurate measurements if necessary.

The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

2.2.4.2 Steel Deck with Concrete Filled Grid (Element 29)

This element defines steel bridge decks with concrete fill either in all of the openings or within the wheel tracks. Concrete filled grid steel decks are similar to open grid steel decks in that a steel grid serves as the deck's structural component. However, the addition of concrete between the bar openings offers much better corrosion protection and a more durable riding surface. The deck system also protects the superstructure below from rain, deicing chemicals, and roadway debris. The main disadvantage is than concrete filled grid steel decks are heavier than open grid decks, although they are still lighter than traditional concrete decks. The concrete fill of these elements may be placed flush with the top layer of bars or is preferably overfilled 1 to 2 inches. The bottom of the fill may be flush with the bottom of the grid or at mid-depth of the main bars (half-filled).

It should be noted that some steel grids contain a bituminous concrete fill. Since the function of bituminous fill on steel grid decks is the same as when conventional concrete is used, bituminous filled steel decks should be inspected and rated in a manner similar as that given in this Section.

Element Level Inspection

This element defines all steel bridge decks with concrete fill either in all of the openings or within the wheel tracks. The steel deck element shall be used to evaluate only the edge and bottom surfaces of the respective element. Per WisDOT policy, the top surface of all deck and slab elements (excluding the Steel Deck – Open Grid element) will be evaluated using an associated wearing surface element. Those deck, slab or top flange elements without an overlay or other type of wearing surface will have the top surface evaluated under element Wearing Surface – Bare (Element 8000). In the case of a concrete filled steel grid, the top surface with concrete would be evaluated using the Wearing Surface – Bare element and the undersurface and sides would be evaluated using the Steel Deck with Concrete Filled Grid element. Refer to Chapter 6 of Part 2 for more information on Wearing Surface elements and their associated material defects.

On the inspection report form, Steel Deck with Concrete Filled Grid is recorded in units of "square feet". The correct method for calculating the deck area is to multiply the structure length by the edge to edge width including any median areas and accounting for any flares or ramps present. Overhangs located under parapets and sidewalks not comprised of steel grid are not included in the deck measurement.

The Steel Deck with Concrete Filled Grid evaluation is three dimensional in nature with the defects observed on the bottom surface and edges, and being captured using the defined defects. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element's condition and help generate quantity/cost estimates for future remedial work.

For most circumstances, the entire deck will be assigned to only one element. Sometimes the inspector will encounter a deck with two or more configurations. This may be found on movable bridges, as it is not uncommon for a movable span to have open grid, filled grid, and concrete deck on various portions of the span.

In the unique situations when the steel grid has concrete in the wheel lines only, the area of filled deck should be coded under Element 29. Multiple deck elements may be required to be entered on the inspection form, with the square footage distributed appropriately among the elements.

Maintenance inspection of concrete filled grid steel decks should include the following items:

- Checking for grid expansion at the joints and bridge ends. This is often caused by corrosion. The deck panels may bow upward.
- Looking for concrete filler that is cracked, broken out or missing all together.
- Examining the bearing bars in the bearing areas at stringers/girders for cracked welds or broken fasteners. Special attention should be paid at the tension areas of the bars.
- Looking for cracked, broken, or missing bars.
- Checking for corrosion and related section loss. A caliper is useful to measure the remaining section.
- Listening for any rattling as traffic passes over the deck. Rattling suggests loose, broken, or missing fasteners.
- Checking any repair plates placed over the grid to make sure it is still securely fastened. Repair plates tend not to be very durable.

On the report, the inspector should describe cracks in terms of their location, orientation, length, and maximum width. Indicate also if the cracks are structural or nonstructural.

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects. However, only the controlling defect will be counted in the total element condition state quantity.

- Corrosion (1000)
- Cracking (1010)
- Connection (1020)
- Distortion (1900)

Condition State Commentary

The top surface of the deck should be evaluated under the appropriate wearing surface element. This includes those steel decks that are intended to have a concrete deck. For instance, a concrete filled steel deck grid would be evaluated using the element Wearing Surface – Bare (Element 8000) for the top surface evaluation and Steel Deck with Concrete Filled Grid for the evaluation of the edges and undersurface of the deck.

The inspector is responsible to carry all necessary equipment to make accurate measurements if necessary.

The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

2.2.4.3 Steel Deck Corrugated/Orthotropic/Etc. (Element 30)

Orthotropic steel decks differ from corrugated steel decks in that the ribs of an orthotropic deck are fastened to the underside of a flat thin steel plate closing off the ribs. In a corrugated deck the corrugations are pressed into a steel plate creating troughs and crests. The deck is then fastened to the superstructure and filled in with gravel, asphalt or other fill material for a driving surface.

Exodermic decks would fall under this element. While an exodermic deck makes use of a steel grid to tie the concrete deck to the structural inverted tee beams, it is a much more robust configuration. Furthermore, the inverted tee beams that bare on the superstructure components are the primary steel decking components. An exodermic deck relies on the grid configuration of its bearing, distribution and tertiary bars to transfer the cast-in-place concrete deck that partially envelops the distribution bars. The CIP deck also contains a single mat of reinforcing bars to further integrate the lower grid deck to the concrete deck. The lower steel portion of the deck is intended to take all tensile loading in bending while the concrete takes only compressive loading.

Element Level Inspection

This element defines all steel bridge decks constructed of corrugated metal filled with Portland cement, asphaltic concrete, or other riding surfaces. The steel deck element shall be used to evaluate only the edge and bottom surfaces of the respective element. Per WisDOT policy, the top surface of all deck and slab elements (excluding the Steel Deck – Open Grid element) will be evaluated using an associated wearing surface element. Those deck, slab or top flange elements without an overlay or other type of wearing surface will have the top surface evaluated under element Wearing Surface – Bare (Element 8000). In the case of a corrugated, orthotropic or other steel deck, the top surface with concrete would be evaluated using the Wearing Surface – Bare element and the undersurface and sides would be evaluated using the Steel Deck Corrugated/Orthotropic/Etc. element. Refer to Chapter 6 of Part 2 for more information on Wearing Surface elements and their associated material defects.

On the inspection report form, Steel Deck Corrugated/Orthotropic/Etc. is recorded in units of “square feet”. The correct method for calculating the deck area is to multiply the structure length by the edge to edge width including any median areas and accounting for any flares or ramps present. Overhangs located under parapets and sidewalks not comprised of steel deck are not included in the deck measurement.

The Steel Deck Corrugated/Orthotropic/Etc. evaluation is three dimensional in nature with the defects observed on the bottom surface and edges, and being captured using the defined defects. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element’s condition and help generate quantity/cost estimates for future remedial work.

For most circumstances, the entire deck will be assigned to only one element. Sometimes the inspector will encounter a deck with two or more configurations. This may be found on movable bridges, as it is not uncommon for a movable span to have open grid, filled grid, and concrete deck on various portions of the span.

Maintenance inspection of corrugated/orthotropic/etc. steel decks should include the following items:

- Observing the driving surface. Heavy cracking or areas of high density potholes may be an indication of debonding of the overlay, pack rust build up between overlay and plate or cracking in the steel plating.
- Examining the ribs and corrugations in the bearing areas at stringers/girders for cracked welds or broken fasteners. Special attention should be paid at the tension areas of the decking.
- Looking for cracked, broken, or missing ribs or corrugations.
- Checking for corrosion and related section loss. A caliper is useful to measure the remaining section if a hole is present within a rib. A D-meter (ultrasonic testing device) is also useful for detecting remaining thickness.
- Listening for any rattling as traffic passes over the deck. Rattling suggests loose, broken, or missing fasteners.
- Checking any repair plates. The inspector should note the location and connection detail to the deck.

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects. However, only the controlling defect will be counted in the total element condition state quantity.

- Corrosion (1000)
- Cracking (1010)
- Connection (1020)
- Distortion (1900)

Condition State Commentary

The top surface of the deck should be evaluated under the appropriate wearing surface element. This includes those steel decks that are intended to have a concrete deck. For instance, a concrete filled steel deck grid would be evaluated using the element Wearing

Surface – Bare (Element 8000) for the top surface evaluation and Steel Deck with Concrete Filled Grid for the evaluation of the edges and undersurface of the deck.

The inspector is responsible to carry all necessary equipment to make accurate measurements if necessary.

The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

2.2.5 Timber Elements

Timber decks are normally used for timber superstructures, although they are occasionally found on older steel superstructures. Timber decks may also be referred to as decking or timber flooring. Timber decking is typically considered non-composite due to the inefficient transfer of forces through to the superstructure elements. There are several types of timber decks:

1. **Plank deck:** These are the most common types of timber decks found in Wisconsin. Deck planks are simply sawn timber planks laid flat across the tops of the timber beams or steel stringers. They span transversely between the beams/stringers and are fastened to the superstructure with nails or bolt clamps. Common plank size is 3 to 6 inches thick and 10 to 12 inches wide.

Figure 2.3.5-1: Timber Plank Deck (Top Surface Evaluated as Wearing Surface – Bare).

2. **Nail laminated deck:** This deck type uses sawn planks laid on edge across the tops of the timber beams or steel stringers, creating a very stiff deck. Each plank is placed tight against and nailed to the adjacent one. When used in conjunction with timber superstructures, each plank is toe nailed to the beam. When used in conjunction with steel superstructures, the deck is attached with clamps at regular intervals. Common laminations size is 2 inches thick and 4 to 12 inches wide.

3. **Glued laminated deck:** These decks are similar to nail laminated decks, but the planks are glued together in a factory and shipped to the job site in 3- to 5-foot wide planks. After setting the planks on top of the superstructure, the planks are sometimes clamped together using dowels. The deck is then fastened down to the beams/stringers using nails, bolts, clip angles, or nailers. Glued laminated decks are stronger, stiffer, and more water-resistant than conventional deck types. Because of this, glued laminated decks are used most often for timber decks in new designs.

4. **Stressed laminated deck:** These decks use laminated timbers similar to nail and glued laminated decks. They are different in that external prestressing (post-tensioning) is used to clamp the laminations together by use of high strength steel bars that run the full width of the deck. The individual laminations work together as a unit due to the large frictional forces generated by the prestressing. Normally, the

steel rods passing through the laminations to deliver the prestressing forces are at approximately 2-foot centers.

5. **Structural composite lumber deck:** These decks include laminated veneer lumber (LVL) and parallel strand lumber (PSL). LVL is fabricated by adhering thin sheets of rotary peeled veneer together. PSL is fabricated by compressing and adhering narrow strips of veneer together with the wood grain parallel. These decks are comprised of fully composite tee beams or box beams. The superstructure components are pulled together by use of steel rods or prestressing strands that pass through the top flange (deck).

Because of timber's low resistance to abrasion, wearing surfaces are often used. These surfaces may consist of timber or steel running boards or asphalt. Running boards are placed longitudinal to traffic, normally only along the wheel paths. They are easily replaced once worn. Asphalt wearing surfaces may be placed on any deck type, although the asphalt tends to crack and deteriorate quicker on plank decks due to plank flexibility and differential deflection.

Timber slab bridges are constructed using either glue-laminated or nail-laminated sawn lumber placed longitudinally between supports. The slab acts as a single wide beam spanning from substructure unit to substructure unit. There are no individual beams with this type of bridge, so the slab also acts as the deck.

Slabs are used for simple spans of about 35 feet or less and for continuous spans of slightly greater lengths. Glue-laminated slab depths range from 6-3/4 inches to 14-1/4 inches thick, using individual strips of dimensional lumber 3/4 to 2 inches thick to form 42-inch to 54-inch wide panels. Nail-laminated slab depths range from 8 inches to 16 inches deep, using 2-inch to 4-inch dimensional lumber.

For maximum strength and stiffness, the lumber width is oriented vertically in the completed structure. Timber slabs may have transverse distributor beams attached to their undersides as a method to distribute live loads across the entire bridge width. Steel transverse post-tensioning rods (Element 8165) may also be used for this purpose, as well as to keep the planks in alignment on glue-laminated slabs.

Figure 2.3.5-2: Steel Running Boards on a Timber Deck.

2.2.5.1 Timber Deck (Element 31)
Timber Slab (Element 54)

Decks differ from slabs in that a deck lies atop superstructure components, i.e. girders or stringers. Slabs are both the deck and superstructure component and span from substructure unit to substructure unit.

Element Level Inspection

These elements define all timber bridge decks and slabs regardless of the wearing surface or protective systems used. Deck and slab elements shall be used to evaluate only the side and bottom surfaces of the respective element. Per WisDOT policy, the top surface of all deck and slab elements (excluding the Steel Deck – Open Grid element) will be evaluated using an associated wearing surface element. Those deck, slab or top flange elements without an overlay or other type of wearing surface will have the top surface evaluated under element Wearing Surface – Bare (Element 8000). Timber planks used along running wheel lines shall be included under the wearing surface Element 510 – Wearing Surface (Other). Refer to Chapter 6 of Part 2 for more information on Wearing Surface elements and their associated material defects.

On the inspection report form, timber decks, and slabs are recorded in units of “square feet”. The deck or slab evaluation is three dimensional in nature with the defects observed on the bottom surface and edges, and being captured using the defined condition states. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element’s condition and help generate quantity/cost estimates for future remedial work.

Transverse distributor beams, often fastened to a timber slab’s undersides, distribute live loads across the entire bridge width. Steel transverse post-tensioning rods may also be used for this purpose. These elements shall not be considered as part of the slab. Transverse distributor beams should be evaluated as Element 8166 – Timber Spreader Beams (refer to Chapter 4). Post-tensioning rods should be evaluated as Element 8165 – Tension Rods/Post-Tensioned Cables (refer to Chapter 4).

It is important to note that the deck element is only concerned for the top flange of structural composite lumber decks. The remaining portion of the superstructure should be coded as necessary to account for the bottom flange and web of each segment.

Element Level Inspection of timber decks and slabs should include the following items:

- Examining the element’s surface for signs of wear and abrasion, weathering, splitting, crushing, and decay.
- Examining the deck’s outside edges for signs of decay.
- Looking for loose or missing planks.

- Checking the underside of the deck at the superstructure bearing areas. Signs of deterioration in these locations include decay and crushing. Crushing is usually the result of decay. Overloads, however, may also cause crushing of sound wood.

- Looking for fastener deficiencies at the superstructure bearing areas. These deficiencies may include corrosion, looseness, or missing fasteners.

- Checking the underside of the deck in tension areas for excessive deflections, fractures, and transverse cracks. These are signs of excessive flexural stresses and overloads.

- Hammer tapping random and suspect areas to evaluate the wood's soundness. Areas of decay and deterioration are usually noted with a hollow sound.

- Perform probe tests in areas suspected to be experiencing decay. This test entails using an awl, ice pick, or pocketknife, to lift a small sliver of wood from the surface. Wood that lifts up and splinters is sound, while wood that breaks up upon lifting the tool is decaying.

- Drilling or boring suspect planks to estimate the extent of decay.

- Checking for overlay (if present) cracking or deterioration. This can be an indication of excessive flexure and a measure of the amount of moisture and chlorides that are seeping to the timber deck below.

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects. However, only the controlling defect will be counted in the total element condition state quantity.

- Connection (1020)

- Decay/Section Loss (1140)

- Check/Shakes/Cracks/Splits/Delamination (1150)

- Abrasion/Wear (1180)

- Distortion (1900)

Condition StateCommentary

Elements exhibiting damage should report the damage in the note of the report under the defect associated with the damage. For instance, the underside of a slab is struck by vehicular traffic and exhibits section loss due to the loss of material. The defect would be reported under the appropriate defect for section loss with the note indicating the section loss was caused by traffic impact.

The Element Level Inspection Condition States for this element are concerned with mechanical and biological damage. The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013. The following are commentary for each Condition State to aid the inspector.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

Figure 2.3.5.1-1: Timber Deck – Condition State 1.

Figure 2.3.5.1-3: Timber Deck (Railroad Ties) – Condition State 3.

2.2.6 Other Material Elements

Other material decks or slabs are not commonly used in Wisconsin bridge construction. This section shall be used when inspecting a deck or slab element that is comprised of a material other than concrete, steel or timber. Fiber reinforced polymer (FRP) decks or panels would be an example of an Other Deck or Other Slab, respectively.

1. **Fiber reinforced polymer (FRP) deck:** These are decks comprised of a modern bridge material. FRP has been used as a repair and retrofit material in the past. These decks are fabricated using pultruded sections (e.g. honeycomb or trapezoidal shaped I-beams). There are three types of FRP decks: Honeycomb sandwich, Solid core sandwich, and Hollow core sandwich. FRP decks require an overlay due to the low slip resistance of the material. The benefit of these decks is a much lighter structure and ease of installation.

2.2.6.1 Other Material Deck (Element 60)
Other Material Slab (Element 65)

These elements define all other bridge decks and slabs composed of other construction materials regardless of the wearing surface or protective system used.

Element Level Inspection

The other deck or slab elements shall be used to evaluate only the edge and bottom surfaces of the respective element. Per WisDOT policy, the top surface of all deck and slab elements (excluding the Steel Deck – Open Grid element) will be evaluated using an associated wearing surface element. Those deck, slab or top flange elements without an overlay or other type of wearing surface will have the top surface evaluated under element Wearing Surface – Bare (Element 8000). Refer to Chapter 6 of Part 2 for more information on Wearing Surface elements and their associated material defects.

On the inspection report form, Other Material Deck and Other Material Slab are recorded in units of “square feet”. The correct method for calculating the deck area is to multiply the structure length by the edge to edge width including any median areas and accounting for any flares or ramps present. Overhangs located under parapets and sidewalks are included in the deck measurement.

The Other Material Deck or Other Material Slab evaluation is three dimensional in nature with the defects observed on the bottom surface and edges, and being captured using the defined defects. Where multiple condition states exist within a unit of measure only the predominant defect in severity and extent is recorded. The other defects located within the unit of measure shall be captured by the inspector under the element or appropriate defect notes. The sum of all of the reported condition states must equal the total quantity of the element. This will quantify the element’s condition and help generate quantity/cost estimates for future remedial work.

Element Level Inspection of other material decks or slabs should include the following items:

- Examining the overlay for signs of wear and abrasion, cracks, potholes, and impending potholes. This can be an indication that the deck structure itself is deflecting excessively or damaged.

- Examining the deck's outside edges for signs of deterioration.

- Looking for loose or missing segments.

- Checking the underside of the deck at the superstructure bearing areas. Signs of deterioration in these locations include cracking, blistering, fiber exposure, or wrinkling.

- Looking for fastener deficiencies at the superstructure bearing areas. These deficiencies may include corrosion, looseness, or missing fasteners.

- Checking the underside of the deck in tension areas for excessive deflections and cracks. These are signs of excessive flexural stresses and overloads.

- Checking for general deterioration such as discoloration, weather, debonding, etc.

Element Defects

Refer to Appendix A for defect descriptions. The defects listed are unique to the element and element material (i.e. concrete, steel, timber, etc.). The order of the defect numbering indicates the controlling defect. Given multiple defects of the same condition state within a unit of measure, the lowest numbered defect controls. Structural defects shall be coded in their entirety on the inspection report regardless if overlapping with material defects. However, only the controlling defect will be counted in the total element condition state quantity.

- Corrosion (1000)
- Cracking (1010)
- Connection (1020)
- Delamination/Spall/Patched Area (1080)
- Deterioration (1220)
- Distortion (1900)

Condition State Commentary

Elements exhibiting damage should report the damage in the note of the report under the defect associated with the damage. For instance, the underside of a slab is struck by vehicular traffic and exhibits section loss due to the loss of material. The defect would be reported under the appropriate defect for section loss with the note indicating the section loss was caused by traffic impact.

The Element Level Inspection Condition States for this element are concerned with mechanical and biological damage. The defects and condition state definitions are based on the AASHTO Manual for Bridge Element Inspection, First Edition 2013. The following are commentary for each Condition State to aid the inspector.

Appendix A defines the Condition States for each individual defect. The defects are expounded on and critical areas are discussed to aid the inspector in determining the severity of a defect. The WisDOT Field Manual tabulates the element defects listed above and bases the Condition States on the progression of severity for each defect. The Condition States are comprised of general descriptions and uniquely colored to follow the severity the description represents.

- Condition State 1 Good Green
- Condition State 2 Fair Yellow
- Condition State 3 Poor Orange
- Condition State 4 Severe Red

2.2.7 Deck National Bridge Inventory (NBI) Condition Ratings

In addition to element level inspection and Condition States, part of every Routine Inspection is rating the deck according to the FHWA General Condition Rating Guidelines. The numeric condition ratings of these guidelines describe existing bridge components in comparison to their as-built condition. Ratings range from 9 to 0, with 9 describing components in excellent condition and 0 describing failed components.

Because only a single number is used to rate the deck, the rating must characterize its overall general condition. The rating should not be used to describe local areas of deterioration, such as an isolated spall or area of heavy leaching. However, widespread spalling or heavy leaching would certainly influence the rating. A proper rating will therefore consider deterioration severity plus the extent to which it is distributed throughout the deck.

NBI ratings are used to evaluate the state of deterioration of the deck material. Material condition is independent of a bridge's design load-carrying capacity. Therefore, postings or original design capacities less than current legal loads will not influence the rating. Similarly, temporary deck support does not change or improve the condition of the deck material. Temporary strengthening methods will therefore not influence the deck rating. Finally, since bituminous overlays are nonstructural in nature, they do not have an influence on the deck rating.

Decks that are built integral with the superstructure (concrete and steel box girders, decks of reinforced concrete tee beam bridges, etc.) are rated as separate components from the superstructure. In other words, since the superstructure is not part of the deck, the superstructure NBI rating should not influence the deck NBI rating.

On slab bridges, the deck is the same structural component as the superstructure. The FHWA Guidelines specifically state that ratings of decks built integral with superstructures (including slabs) should not be influenced by the superstructure rating. However, since the deck NBI rating accounts for inspection findings both on the top and underside, NBI condition ratings of the deck and superstructure must be the same.

The NBI general condition ratings found in the FHWA guidelines apply to decks, superstructures, and substructures. Ratings 9 through 6 apply to components built of any material, while ratings 5 through 0 mention specific defects or deterioration that can be applied to certain materials. Because the NBI general condition ratings apply to a wide range of components and materials, Wisconsin has developed supplemental rating guidelines. These supplemental rating guidelines are used to assist the inspector in properly assigning condition ratings to specific components constructed of the most commonly used materials.

The general condition ratings and Wisconsin supplemental rating guidelines for decks are given below, followed by a summary chart for concrete decks:

Code (Rating) Description

N **NOT APPLICABLE**

Wisconsin Supplemental Rating Guidelines:

Used for culverts or filled spandrel arch bridges.

9 **EXCELLENT CONDITION**

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – there are no spalls, delaminations, cracks or scaling present. The electric potential is 0.0 volts, and there is no chloride within the deck.

Steel Grid Deck – there are no noticeable or noteworthy deficiencies which affect the deck condition.

Timber Deck – there are no noticeable or noteworthy deficiencies which affect the deck condition.

Other Deck – the deck is in excellent condition, typically due to new construction. After initial or first routine inspection, most decks/slabs should be rated an 8 due to exposure.

8 **VERY GOOD CONDITION –** no problems noted.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – there are no spalls, delaminations, cracks or scaling present. Minor transverse cracks may be present. There are no areas on the deck with an electric potential greater than 0.35 volts. The chloride content within the deck is less than 2.0 pounds per cubic yard.

Steel Grid Deck – there is no damage to the primary or secondary bars other than surface rust on unpainted decks. The paint system on coated decks is sound. The grid deck is securely fastened to the floor system, and any concrete filler present is sound.

Timber Deck – there is no crushing, rotting, or splitting. The deck is tightly secured to the floor system.

Other Deck – there are no significant problems noted.

7 **GOOD CONDITION –** some minor problems.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – there are no spalls or delaminations present. Cracks which can be sealed with tar or epoxy exist, or light scaling may be present. Up to 10% of the deck area has an electric potential greater than 0.35 volts. Up to 10% of the deck area has a chloride content greater than 2.0 pounds per cubic yard.

Steel Grid Deck – there may be minor damage to the primary or secondary bars, such as small twists or bends. There may be surface rust on unpainted decks, or minor isolated areas of corrosion of painted decks. Any concrete filler present is sound.

Timber Deck – there is minor checking or splitting with a few loose planks.

Other Deck – there is minor surface damage in the form of hairline cracking in resin and scratches. No delaminations are present.

6 **SATISFACTORY CONDITION –** structural elements show some minor deterioration.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – less than 2% of the deck area is spalled or less than 5% is delaminated. Excessive open cracking exists (5-foot maximum spacing) or moderate scaling may be present. Ten to 20% of the deck area has electric potential greater than 0.35 volts. Ten to 20% of the deck area has a chloride content greater than 2.0 pounds per cubic yard.

Steel Grid Deck – there may be some twisted, bent, or cracked bars. There may be some isolated broken welds or loose/broken fasteners. Concrete filler may have broken out at a few localized areas. There is surface rust on unpainted decks, and surface or freckle rust of painted decks.

Timber Deck – some planks are checked or split, but they are sound. There may be some loose or moderately worn planks. Any fire damage is limited to surface charring with minor, measurable section loss. Some areas of wetness are present.

Other Deck – there is some measureable damage over less than 2% of the total area. FRP's showing cracks in resin, scratches, blistering, abrasion, and small delaminations. Fibers at damaged areas are not exposed or buckled. Delaminations are smaller than 4 inches in every dimension and located away from structurally significant details (i.e. tension flange at midspan)

5 **FAIR CONDITION –** all primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – 2% to 5% of the deck area is spalled, or 5% to 20% is delaminated. Excessive open cracks or heavy scaling may exist. Twenty to 40% of the deck area has an electric potential greater than 0.35 volts. Twenty to 40% of the deck area has a chloride content greater than 2.0 pounds per cubic yard.

Steel Grid Deck – there are some twisted, bent, or cracked bars and possibly a few broken or missing bars. There are some broken welds or loose/broken fasteners. Concrete filler may have broken out at a few scattered locations. Some section loss may be occurring due to corrosion, but the section loss is not very measurable. Section loss due to wear may be noticed in the wheel lines.

Timber Deck – numerous (30-40%) of the planks are checked, split, rotted or crushed. Many planks are loose. Fire damage is limited to surface charring with minor, measurable section loss. Some planks (<10%) are in need of replacement.

Other Deck – there is measureable deterioration and/or section loss over 2-10% of the total area. In FRPs, damage showing cracks in resin, scratches, blistering, abrasion, and small delaminations. Fibers in cracks are exposed but not debonded, buckled, or ruptured. Delaminations are less than 8 inches in all dimensions and are located away from structurally significant details.

4 **POOR CONDITION –** advanced section loss, deterioration, spalling, or scour.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – greater than 20% of the deck area is delaminated. Full-depth failures are present or imminent. Excessive leaching exists. Over 60 percent of the deck area has an electric potential greater than 0.35 volts. Over 60 percent of the deck area has a chloride content greater than 2.0 pounds per cubic yard.

Steel Grid Deck – there are numerous cracked, broken, or missing bars. There are numerous broken welds or loose/broken fasteners. Concrete filler has broken out at scattered locations. Measurable surface pitting/section loss is occurring due to corrosion, reducing the grid deck's load carrying capacity. The paint system of coated decks has failed. Measurable section loss due to wear has occurred in the wheel lines.

Timber Deck – the majority (over 40%) of the planks are rotted, crushed, or split. Fire damage exists that has significant section loss, possibly reducing the load carrying capacity of the member. Over 10% of the planks are in need of replacement.

Other Deck – there is significant surface damage over 10-25% of the total area. In FRPs, damage is cracks in resin, scratches, blistering abrasion, and delamination. Fibers in cracks are exposed but not debonded, buckled or ruptured. Delaminations are less than 8 inches in all dimensions but are located near structurally significant details.

3 **SERIOUS CONDITION –** loss of section, deterioration, spalling, or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – many full-depth failures are present or imminent. Excessive leaching exists.

Steel Grid Deck – there are numerous broken or missing bars. There are widespread broken welds or broken fasteners. Several areas of concrete filler are missing. Section loss has reduced the grid deck's load carrying capacity. Measurable section loss due to wear has occurred in the wheel lines.

Timber Deck – severe signs of structural distress are visible. Extensive plank damage is evident with a reduced deck load carrying capacity.

Other Deck – there is significant surface damage over greater than 25% of the total area warranting structural analysis to determine load capacity. In FRP's damage is deep cracking in resin, scratches, blistering, abrasion, and delamination. Fibers are exposed but not debonded, buckled, or ruptured at damaged locations. Delaminations are smaller than 14 inches in every dimension.

2 **CRITICAL CONDITION –** advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – full-depth failures exist over much of the deck. The deck structural capacity is grossly inadequate.

Steel Grid Deck – there are widespread broken or missing bars accompanied with partial deck failures. There are widespread broken welds or broken fasteners. Much of the concrete filler is missing. It may be necessary to close the bridge until corrective action is taken.

Timber Deck – advanced deterioration with partial deck failure. It may be necessary to close the bridge until corrective action is taken.

Other Deck – there is significant surface damage over the majority of the deck and warranting structural analysis to determine load capacity. If not closely monitored, bridge should be posted for reduced loads or closed. In FRPs, Fibers are exposed, debonded and ruptured or buckled at damaged locations. Delaminations are larger than 24 inches in any dimension.

1 **“IMMINENT” FAILURE CONDITION –** major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structural stability. Bridge is closed to traffic but corrective action may put it back in light service.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – bridge is closed. Corrective action may put it back in light service.

Steel Grid Deck – bridge is closed. Corrective action may put it back in light service.

Timber Deck – bridge is closed. Corrective action may put it back in light service.

Other Deck – bridge is closed. Corrective action may put it back in light service.

0 **FAILED CONDITION –** out of service, beyond corrective action.

Wisconsin Supplemental Rating Guidelines:

Concrete Deck – the bridge is closed. Deck replacement is necessary.

Steel Grid Deck – the bridge is closed. Deck replacement is necessary.

Timber Deck – the bridge is closed. Deck replacement is necessary.

Other Deck - the bridge is closed. Deck replacement is necessary.

DECK RATING	CRACKING	SCALING	SPALLING	DELAM.	ELECTRICAL POTENTIAL (VOLTS)	CHLORIDE CONTENT (LB/CY)
9	None	None	None	None	0	0
8	Minor Transverse	None	None	None	None >0.35	None >2.0
7	Sealable	Light	None but visible tire wear	None	10% >0.35	10% >2.0
6	Excessive (open cracks @ 5-foot maximum spacing)	Moderate	<2%	<5%	10-20% >0.35	10%-20% >2.0
5	Excessive	Heavy	2%-5%	5%-20%	20-40%* >0.35	20%-40%* >2.0
4	Many full depth failures present or imminent; leaching			>20%	Over 60%* >0.35	Over 60%* >2.0
3	Many full depth failures present or imminent; leaching					
2	Full depth failures over much of deck					
1	Bridge Closed. Corrective action may put back in service					
0	Bridge Closed. Replacement necessary					

Note: Values are guidelines only