


Major Superstructure – Inspection and Rating


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# Major Superstructure Inspection and Rating

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## Wearing Surface

- Bonded or fastened to the deck
- In direct contact with the traffic
- Not part of the “structural” deck
- Purpose
  - Protects the bridge deck
    - traffic wear
    - salt and water infiltration
  - Provides a smooth wearing surface
  - Provides skid resistance

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## Wearing Surface

- Types
  - Asphalt
  - Timber
    - untreated
    - treated
  - Polymer membranes
  - Concrete overlay
    - silica fume
    - high density
    - latex modified
    - other (Pyrament)
    - fibre reinforced
  - May have more than one type
    - i.e. polymer membrane on concrete overlay

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## Wearing Surface

- Drive over deck at design or posted speed
- Observe traffic crossing bridge
  - Look for deflections or movement
  - Listen for unusual noises
- Look for defects common to the material
- Look for debonding, loosening or loss of wearing surface
  - Sound for debonding using hammer if suspected
- Look for protruding nails in timber wearing surfaces
- Look for loss of aggregate from polymer wearing surfaces or seal coats
- Look for polishing of concrete overlays especially high density

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## Wearing Surface


Wearing Surface/Deck Top Detail Ratings	1 (PO)	2 (NO)	3 (NO)
Level			
Skid			
Wearing Surface (Minimum Type 1)			
(Minimum Item 1)			
(Peak Width Item 1)			

- TT, TH and PT forms

Wearing Surface/Deck Top Detail Ratings	1 (PO)	2 (NO)	3 (NO)
Level			
Skid			
Wearing Surface (Minimum Type 1)			
(Minimum Item 1)			
(Peak Width Item 1)			
Concrete Integrity (Lateral Connection Problem (Y/N))			
Deck Top			


PCS and PSR only

- PCS, PSR, SG, SS, DT and CON forms



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## Wearing Surface

- Record or verify type
- Record or verify
  - Thickness
  - Size (TH & PT only)
- Record or verify the presence of Lateral Connection Problem (Y/N)
  - PSR and PCS only
  - Rate under girders
- If no wearing surface, rating is for Deck Top
  - TH, PT and TT only



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## Wearing Surface

- Record in *Explanation of Condition* location, severity and extent of
  - Wear
  - Scaling / raveling
  - Cracks
  - Debonding
  - Wearing surface loss



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## Wearing Surface

- Rate according to existing condition and functionality
- If wearing surface does not have sufficient skid resistance
  - rate 4 or less
- If wearing surface does not cover the entire deck (curb to curb)
  - rate 4 or less
  - rate 2 if traffic hazard
- Exposed nails or other fasteners
  - rate 4 or less
- If speed has to be reduced due to potholes, missing planks, ruts or other deterioration
  - rate 3



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## Wearing Surface

**Concrete Overlay Rating Guide**

Rating	Scaling	Cracks	Debond	Spalls / Patches
7		HN ≤ 1/30 m/m <sup>2</sup>		
6		HN ≤ 1/10 m/m <sup>2</sup> MW ≤ 1/30 m/m <sup>2</sup>	≤ 1%	
5	Light	HN ≤ 1/3 m/m <sup>2</sup> MW ≤ 1/10 m/m <sup>2</sup>	≤ 3%	
4	Moderate	HN ≤ 1/1 m/m <sup>2</sup> MW ≤ 1/3 m/m <sup>2</sup>	≤ 10%	≤ 1%
3	Heavy	HN > 1/1 m/m <sup>2</sup> MW ≤ 1/1 m/m <sup>2</sup>	≤ 30%	≤ 3%
2	Severe	HN > 1/1 m/m <sup>2</sup>	> 30%	≤ 3%

- Crack definitions
  - Hairlines <0.1 mm
  - Narrow ≥0.1 mm and <0.3 mm
  - Medium ≥0.3 mm and <1.0 mm
  - Wide ≥1.0 mm

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## Wearing Surface

**Asphalt Pavement Condition Severity Guide**

Rating	Ravelling	Cracking
5	Some loss of Material	Less than 10mm interconnecting cracks
4	Shallow disintegration of surface, open texture	10 to 20mm Alligator pattern, corners of polygons fracturing
3	Shallow disintegration of surface, small potholes, open texture, loose material	20 to 30mm no ravelling Alligator pattern, spalling of polygon blocks
2	Deep disintegration of surface, numerous potholes. Very open texture, loose material	Greater than 30mm ravelling edges Alligator cracking, blocks lifting, potholes

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## Wearing Surface

**Asphalt Pavement Condition Severity Guide (Part 2)**

Rating	Flushing	Slipperiness	Rutting and Surface Distortion
5	Variable color, localized veining	Skid number 40 to 50	Under 10 mm
4	Distinct color, free asphalt	Skid number 30 to 40	10 mm to 25 mm
3	Wet look. Traffic leaves tire marks and noise	Skid number 20 to 30	25 mm to 50 mm
2	Excess free asphalt, wet look, footprints	Skid number under 20	Over 50 mm

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## Wearing Surface

**Wearing Surface Rating Guide - ACP**

Rating	Alligator / Cracking, Ravelling, Rutting and Surface Distortion, Flushing, Slipperiness	Longitudinal / Transverse / Random Cracking	Loss (potholes and patches)	Debond
6		< 1/30 m/m <sup>2</sup>		< 1%
5	Light	< 1/10 m/m <sup>2</sup>	< 1%	< 3%
4	Moderate	< 1/3 m/m <sup>2</sup>	< 3%	< 10%
3	Heavy	< 1/1 m/m <sup>2</sup>	< 10%	< 30%

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## Wearing Surface

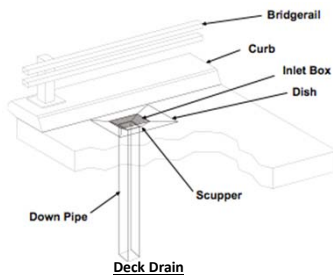
### Wearing Surface Rating Guide Polymer / Seal Coat

Rating	Seal Coat Loss	Polymer Debond / Loss	Polymer Cracking	Slipperiness
7	≤ 1%			
6	≤ 3%	≤ 1%	≤ 1/30 m/m <sup>2</sup>	
5	≤ 10%	≤ 3%	≤ 1/10 m/m <sup>2</sup>	Light
4	≤ 30%	≤ 10%	≤ 1/3 m/m <sup>2</sup>	Moderate
3	over 30 %	< 30%	≤ 1/1 m/m <sup>2</sup>	Heavy
2		> 30%	≥ 1/1 m/m <sup>2</sup>	Severe

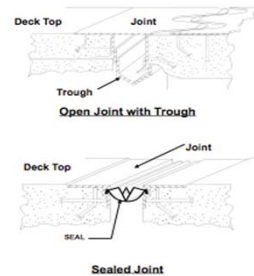
## Deck Drainage

- Not included on TT, PT or TH forms
- Poor drainage
  - Common cause of deck deterioration
  - May cause a hazard due to hydroplaning or icing
  - Caused by inadequate design, construction or maintenance practices
  - May affect other bridge elements
    - superstructure
    - substructure
    - headslopes and sideslopes
- Drainage system includes
  - gutters, inlet boxes, scuppers, downpipes and catch basins
  - drainage problems at deck joints
    - sealed
    - with plumbing
    - non-watertight

## Deck Drainage



## Deck Drainage




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## Deck Drainage


- Check for:
  - plugging of inlet boxes, scuppers, downpipes and joint plumbing
  - corrosion of metal components
  - gouges, cracks, breaks or tears
    - joint seals
  - integrity of attachments and connections
    - loose or missing bolts
    - cracked or broken welds
    - loose or open connections
  - length of downpipes

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## Deck Drainage


- Check for:
  - signs of ponding on the deck
  - damage to the deck, curbs, girders and substructure
    - staining (water and rebar corrosion)
    - scaling
    - freeze-thaw
    - delaminations
    - spalling
  - erosion below downpipe

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## Deck Drainage

Deck Drainage				
Drains Clogged (Y/N)				


- Record or verify if drains or joint plumbing is clogged

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## Deck Drainage


- For timber decks or steel grating
  - not on TT, TH & PT forms
- water ponded on the deck rate 4 or less
- water ponding is a hazard rate 2
- drains leak or downpipes too short rate 4 or less
- ponding, leakage or discharge causes significant deterioration of deck, curbs, girders or substructure rate 3 or less
- erosion on sideslopes or headslopes from discharge rate 4 or less
- Deck joint leakage causing damage - reduce rating

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## Deck Top/Underside

- Purpose
  - Carries traffic loads
  - Transfers loads to main structural members
  - Can be in direct contact with traffic in the absence of a wearing surface
- Types
  - Cast in place concrete
  - Precast concrete
  - Timber
  - Steel grate
- Separate ratings for top and underside
  - Except for PCS, rate underside with top and girders
- May not be inspectable from the top
  - Wearing surface
  - Snow, ice or gravel



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## Deck Top/Underside

- Drive over deck at design or posted speed
- Observe deck under traffic
  - Listen for unusual noises
  - Look for deflections or movement
- Look over deck top and underside for problems with material
- On concrete decks, sound suspect areas with a hammer to detect delaminations
  - Birdbath locations
  - Stained areas
  - Badly cracked areas or adjacent to large cracks



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## Deck Top/Underside

- Deck Top rated separately except for PT, TH and TT where Wearing Surface / Deck Top combined


<b>Sub Deck/Deck Underside</b>	
(Material Type : )	
(Plank Thickness (mm) : )	
(Plank Width (mm) : )	
Defects (Percent Area)	

- Applies to PT, TH and TT only

<b>Deck Underside</b>	
Stains (Percent Area)	
(Snow Slots Filled : )	

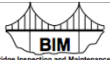
Applies to DT and SS only

- Remainder applies to SG, PSR, CON, DT and SS



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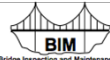
## Deck Top/Underside

- Record or verify subdeck type and size for TH, PT & TT
- Record or verify deck underside
  - % defects for TH, PT & TT
  - % stains for all others
- Record if snow slots filled for DT & SS
- Record location, severity and extent of
  - Staining
  - Scaling
  - Cracks
  - Delaminations
  - Spalling



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## Deck Top/Underside

- Rate according to existing condition and functionality
- Speed reduced due to deterioration
  - rate 4 or less
- Surface does not have sufficient skid resistance
  - rate 4 or less
- Steel grating
  - connections are loose or broken rate 4 or less
  - improper bearing or support on girders rate 4 or less
- Timber
  - minor splitting in non-adjacent planks - rate 5 or more
  - any rot - rate 4 or less
  - broken planks - rate 4 or less
  - connections loose or broken - rate 4 or less



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## Deck Underside

### Concrete Deck Rating Guide


Rating	Scaling	Cracks	Delamination	Spalls / Patches	
7		HN ≤ 1/80 mm <sup>2</sup>			
6		HN ≤ 1/10 mm <sup>2</sup> MW ≤ 1/80 mm <sup>2</sup>	≤ 1%		
5	Light	HN ≤ 1/8 mm <sup>2</sup> MW ≤ 1/10 mm <sup>2</sup>	≤ 3%		Light
4	Moderate	HN ≤ 1/1 mm <sup>2</sup> MW ≤ 1/3 mm <sup>2</sup>	≤ 10%	≤ 1%	Moderate
3	Heavy	HN > 1/1 mm <sup>2</sup> MW ≤ 1/1 mm <sup>2</sup>	≤ 30%	≤ 3%	Heavy
2	Severe	MW > 1/1 mm <sup>2</sup>	> 30%	> 3%	Severe

- Crack definitions
  - Hairline <0.1 mm
  - Narrow ≥0.1 mm and <0.3 mm
  - Medium ≥0.3 mm and <1.0 mm
  - Wide ≥1.0 mm



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## Deck Underside


### Concrete Staining Deck Rating Guide

Severity Rating	Description
5	Efflorescence or exudation at cracks. Light grey damp appearance
4	Dark grey damp appearance
3	Efflorescence or exudation in saturated areas Light rust stains
2	Heavy rust stains



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## Concrete Girders

- Purpose
  - Receive the loads from the deck
  - Transmit the loads to the substructure (through the bearings)
- Three types
  - Cast-in-place standard reinforced
  - Standard reinforced precast
  - Prestressed or post-tensioned precast



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### Concrete Girders

- Inspection is primarily visual, looking for
  - Staining
  - Scaling
  - Cracks
  - Delaminations
  - Spalling
- Observe girders under traffic and look for unusual deflections or movement
  - Independent movement on laterally connected girders
- Evidence of grout key or lateral connection failure
  - Cracking or loss of grout in grout key
  - Cracking in pavement
  - Corrosion, or missing, loose or broken bolts at channel connectors
  - staining on underside of keys



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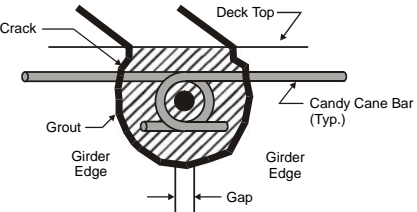



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### Concrete Girders

- Grout key failure





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### Concrete Girders

- On post-tensioned girders check end anchorage zones
- Check for corrosion of prestressing or post-tensioning cables
  - rust stains or cracking along sides of girders
  - leakage onto ends of girders with staining from ends of cables
- Cracking in end anchorage zone of prestressed girders
- High load damage which breaks the concrete around the pre- or post-stressed cables
  - Look for damaged or broken cables



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### Concrete Girders

Girders		
Cracking (Y/N)		
Spalling (Percent Area)		

- Record or verify the presence of cracking
  - PCS, PSR & CON
  - Not hairline/narrow flexural on PCS or CON
- Record or verify the amount of spalling in %
  - PCS and PSR
  - Corrosion induced spalling on bottoms and sides over stirrups only
  - % of total leg or girder length
- Girder Detail Ratings on PCS forms only



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## Concrete Girders

- Record in *Explanation of Condition* location, severity and extent of
  - Staining
  - Scaling
  - Cracks
  - Delaminations
  - Spalling
  - Grout Key failure



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## Reinforced Concrete Girder Rating

- Applies to all plain reinforced concrete girders
  - Not prestressed or post-tensioned
- If curb girder **only** affected, can increase ratings by one
  - Has lower load carrying function
  - Does not apply to shear cracks



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## Reinforced Concrete Girder Rating

Spalling or Longitudinal Cracking on Bottom of Legs


RATING	DESCRIPTION
5	Medium crack & sound concrete - anchor zone Wide crack/spall - other zones
4	Medium crack - anchor zone Wide crack/spall sound concrete - other zones
4	Moderate section loss on main bars or stirrup bends up to 10%
3	Wide cracks or spall with sound concrete - anchor zone
2	Spall with unsound concrete - anchor zone
2	Severe loss of section on main bars or stirrup bends greater than 20%

\*Increase rating one point for:  
 -PG and PA girders **OR** cracking limited to one leg  
 -Defects limited to curb girder only



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## Reinforced Concrete Girder Rating

### Shear Cracks

\*Must be 60 degrees or less from horizontal


RATING	DESCRIPTION
5	Narrow*
3	Medium*
2	Wide or growing*

\*Reduce by one if wide longitudinal crack or spall in anchorage zone



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## Reinforced Concrete Girder Rating

Other Defects

RATING	DESCRIPTION
	No effect Hairline or narrow flexural cracks
6	End diaphragm spall Narrow map cracks
5	Top slab transverse crack
4	Medium or wide map cracking or any map cracking with staining
4	Medium flex or narrow grout key cracks

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## Reinforced Concrete Girder Rating

Other Defects

RATING	DESCRIPTION
4	Small (150mm max) punchouts
3	Medium or wide grout key cracks
3	Other punchouts
3	Failed girder connectors
2	Wide flexural cracks
2	End diaphragm spall extending into legs

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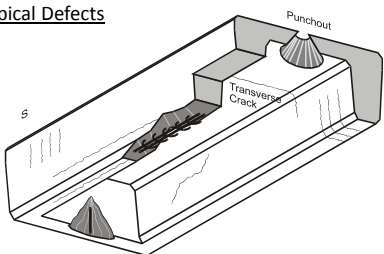
  
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## Reinforced Concrete Girder Rating

Typical Defects




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## Prestressed Concrete Girder Rating

- Applies to all prestressed and post-tensioned concrete girders
- Reduce as needed to reflect condition & function
- If curb girder only affected, can increase ratings by one
  - Has lower load carrying function
  - Does not apply to shear cracks

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## Prestressed Concrete Girder Rating

RATING	DESCRIPTION
4	Hairline cracks*
3	All other cracks*
3	Corrosion stains from strands
2	Cracks with corrosion in webs, flanges or bottom of boxes
2	Any cracks that are growing
1	Cracks opening and closing or with slippage

\*Some cracks are acceptable and don't affect rating

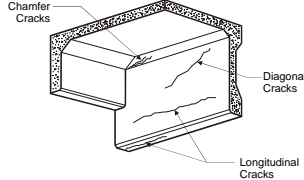


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## Prestressed Concrete Girder Rating



- Chamfer crack at girder ends: N=5, M/W=4
- Longitudinal crack in bottom half of leg at girder ends: H/N= 5 M/W=4
- Longitudinal crack underside of leg: H/N=5, M/W=4
- Diagonal crack in web transition: =5



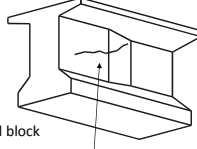
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## Prestressed Concrete Girder Rating

DBT Girders




Crack in girder end block through transition zone

- Diagonal crack in end block area - rate 5
  - Not extending into bottom 1/4 of girder
  - No staining
  - Reduce by 1 if into flange or thin web section



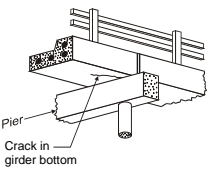
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## Prestressed Concrete Girder Rating


SM,VS, SC, RD,  
RM,PM,VM  
Girders



- Longitudinal crack on underside- rate 5
- Longitudinal crack curb fascia- rate 5
- Crack in fascia at pier connection- rate 5
- Bottom diagonal crack in ends - rate 5
  - Not longer than 0.5m from cap or seat
  - No corrosion staining
  - With corrosion staining- rate 3



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## Diaphragms / Cross Frame


- Purpose
  - Distribute loads between girders
  - Resist torsion forces
  - Support the compression flange of the girder
- Generally made out of the same material as the girder
  - If not, usually steel
- Rate according to condition and ability to function as designed
- If diaphragms contribute to defects in the girder - rate 4 or less

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## Steel Girder


- Purpose
  - Receive loads from the deck
  - Transmit loads to the substructure
- Two types
  - Rolled beam
  - Welded plate girders
- Usually I-shaped
  - Web
  - Flanges
- Each part of girder rated separately
- Stiffeners
  - Vertical at bearings & along span
  - Horizontal in high bending stress areas
- Cover plates
  - Extra plates welded to flanges to increase capacity in high bending areas

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## Steel Girder


- Cracks
  - Tension areas
  - End of cover plates
  - Stiffeners welded to bottom flange
  - Re-entrant corners
  - Changes in section
  - Stiffener welds that cross the weld from flange to web
  - Gouges, nicks, holes, collision damage
- Buckling
  - High stress areas such as at bearings

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## Steel Girder


- Alignment
  - Twists, bows, bends, sags
- Corrosion
  - Top of bottom flange
  - Around connections
  - Under joints
- Connections
  - Loose or missing bolt or rivets
  - Poorly fitted connections
  - Misaligned bolt holes
  - Deformed bolt holes
  - Corrosion between plates
    - warping of plates
- Collision damage
  - Grade separations

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**Steel Girder**

- Notches or stress raisers in tension areas
  - rate 4
- If corrosion is causing a loss of section
  - rate 4 or less
- If any signs of distortion or misalignment
  - rate 4 or less
- If fatigue cracks or signs of distortion
  - rate 4 or less
- Elements with visible cracks
  - rate 3 or less
- Fatigue cracks in bottom flange extending into web
  - rate 2 or less



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**Steel Truss Members**

- Purpose of truss as a unit is to:
  - Receive loads from deck
  - Transmit loads to substructure (through bearings)
- Three types of trusses
  - Through
  - Pony
  - Deck
- Member types are rated separately
- Includes stringers and floor beams
- Truss members in tension or compression
  - Inspector must identify each
  - Different concerns



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## Major Superstructure – Inspection and Rating

**Steel Truss Members**

- Check alignment of trusses
  - top chord alignment especially important because it is in compression
- Check for wide or high load damage
  - If any present, indicate “YES” and explain in *Explanation of Condition*
  - Especially look at portal bracing and sway bracing
  - Wide or high load damage will affect the rating of the member(s) damaged
    - compression members rating are especially lowered by bends
    - tension members by cracks or nicks
  - Check connections and members adjacent to damaged member



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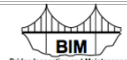
**Steel Truss Members**

- Check each truss member in an orderly fashion
  - On tension members or collision damaged members look for cracks at connections
    - crack will most often be at first bolt hole on the member side
    - light members with significant stress or stress reversal
  - On compression members look for kinks or bows
  - Look for welds or torch cuts
    - crack prone
  - Look for fatigue prone details
    - sharp radius corners
    - notches
    - light members - especially with stress reversal
  - Check which members govern load capacity
    - *Allowable Load* on first page of form



Technical Standards Branch  
Class A Bridge Inspection Course

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## Steel Truss Members

- Check each connection in an orderly fashion
  - Loose or missing bolt or rivets
  - poorly fitted connections
  - misaligned bolt holes
  - deformed bolt holes
  - corrosion between plates
    - warping of plates
- Check for Corrosion
  - Between Built up members
  - Splash zone
  - bottom chord, especially channel section

## Steel Truss Members

- Corrosion causing a loss of section
  - rate 4 or less
- Distortion or misalignment on a tension member, no other defects - rate 5
- Minor misalignment or damage to cross-bracing or portal - rate 5
- Cracks in a tension member - rate 3 or less
- Cracks in a compression member - rate 4 or less
- Any fatigue cracks - rate 4 or less
  - Cracks on bottom flange of floor beam or stringer extending into web - rate 2 or less