New Hampshire Department of Transportation

IN-DEPTH INSPECTION AND CONDITION REPORT FOR THE PORTSMOUTH MEMORIAL BRIDGE OVER THE PISCATAQUA RIVER

247/084

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LICENSED
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10-5-09

VOLUME 1 OF 2

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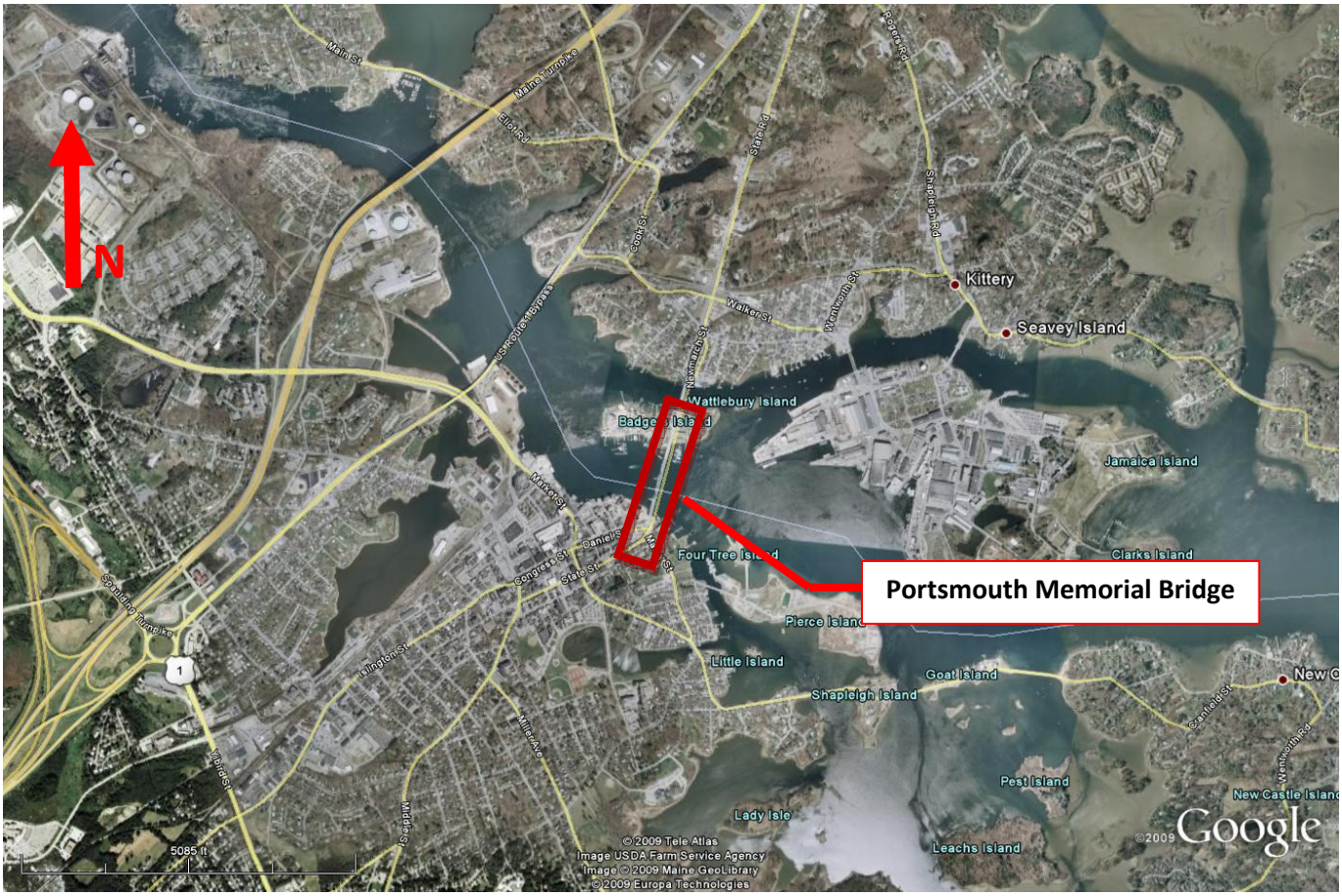
UNDERWATER CONCRETE CORE TESTING REPORT

PAINT EVALUATION REPORT

MECHANICAL & ELECTRICAL INSPECTION REPORTS

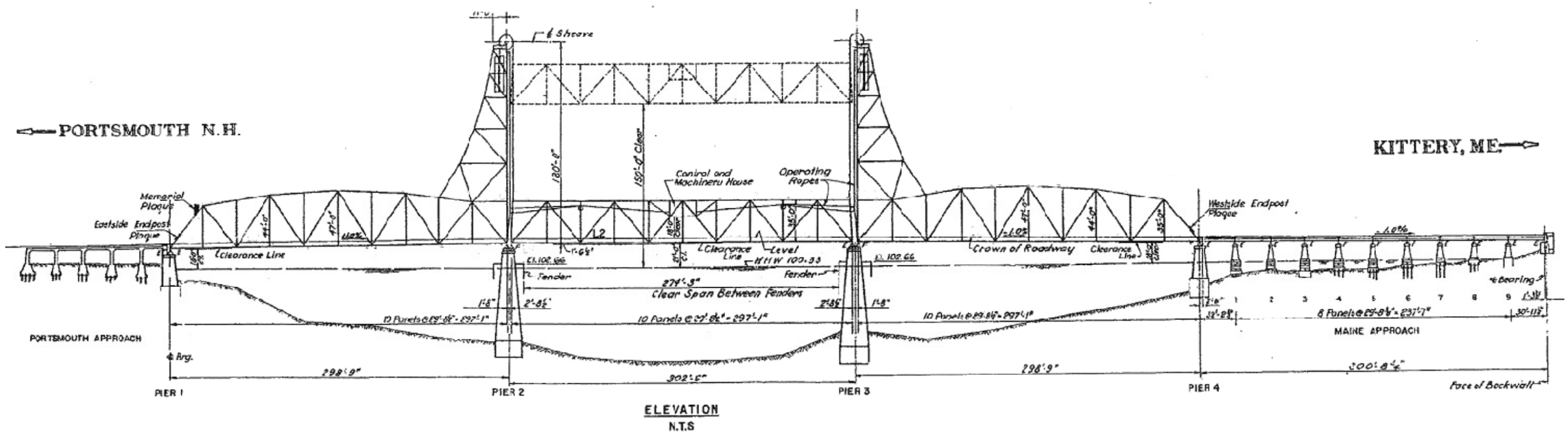
LOCATION MAP

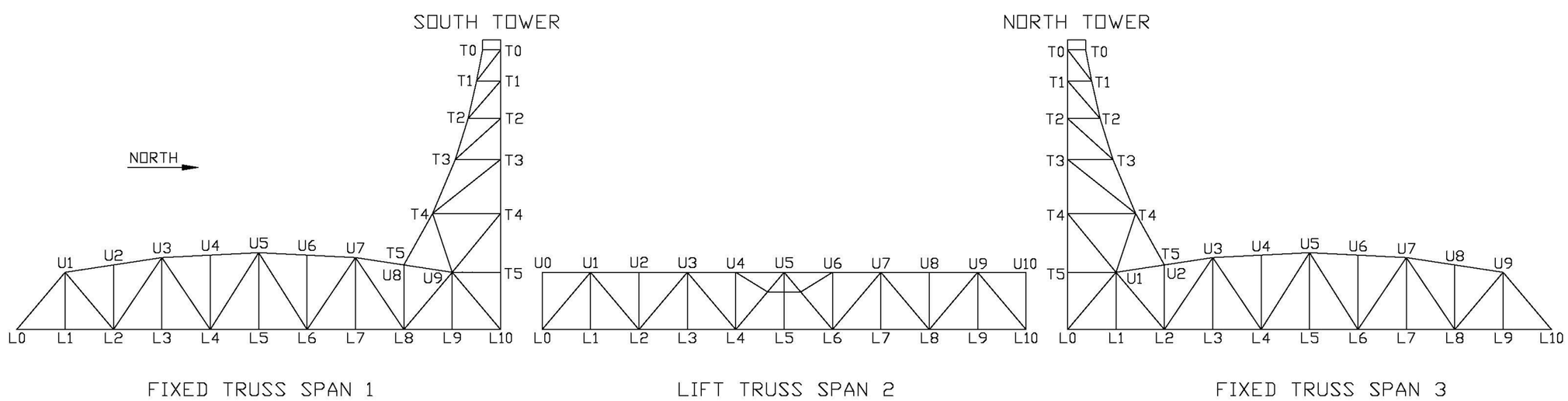


DESCRIPTION OF BRIDGE

Date of Construction:	**1922**
Original Design Loading:	**Equivalent H15 Truck**
Bridge Type:	**Span-Drive Vertical Lift Bridge: Comprised of 3 through-trusses and 10 multi-stringer approach spans. The deck is open steel grating on the lift span and reinforced concrete in the approach spans.**
Skew:	**0°**
Spans:	**13 – Excluding Scott Avenue south approach spans**
Width of Bridge Deck:	**28'-0"**
Roadway Surface:	**Bituminous concrete on approach spans, open steel grating in lift span.**
Sidewalk/Walkway/Median:	**Timber planks supported by steel stringers.**
Bridge Railing:	**Steel pipe rail along sidewalk and steel guard rail along roadway.**
Approach Railing:	**Steel pipe rail**
Superstructure:	**Through-truss main vertical lift span with symmetrical through-truss approach spans. Multiple stringer approach spans on the north or Kittery end.**
Modifications to Original Superstructure:	**The deck had been replaced in the approach spans, numerous welded and bolted plates have been added to floorbeams and truss members. Some stringers have been replaced in the lift span; others have repair channels and plates bolted to the web.**
Utilities:	**Various electric conduits along the structure from both ends of the bridge (for bridge service only).**
Substructure:	**Reinforced concrete with stone masonry fascia in tidal zone.**
Modifications to Original Substructure:	**Most of the original Kittery Approach Span columns have been replaced by circular reinforced concrete columns with a timber protected base filled with concrete.**

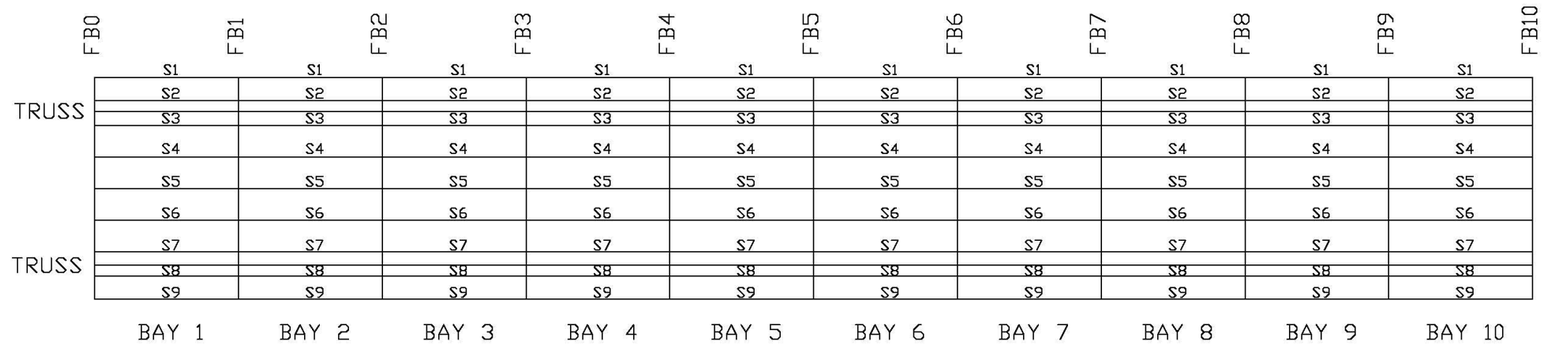
BRIDGE ELEVATION





MEMORIAL BRIDGE ELEVATION

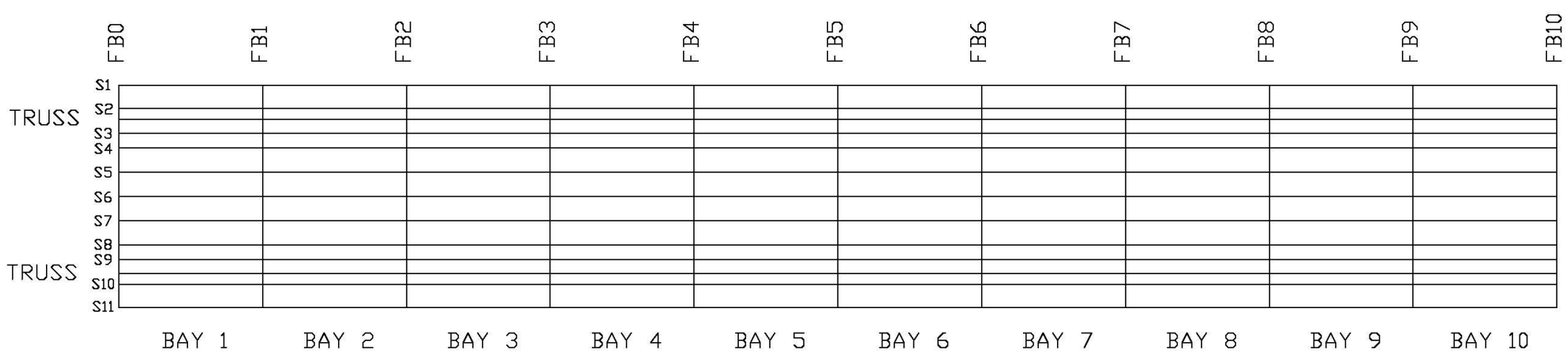
BRIDGE FRAMING PLAN



DECK FLOOR SYSTEM
PURLINS AND STRINGER BRACING EXLUDED FOR CLARITY

NORTH

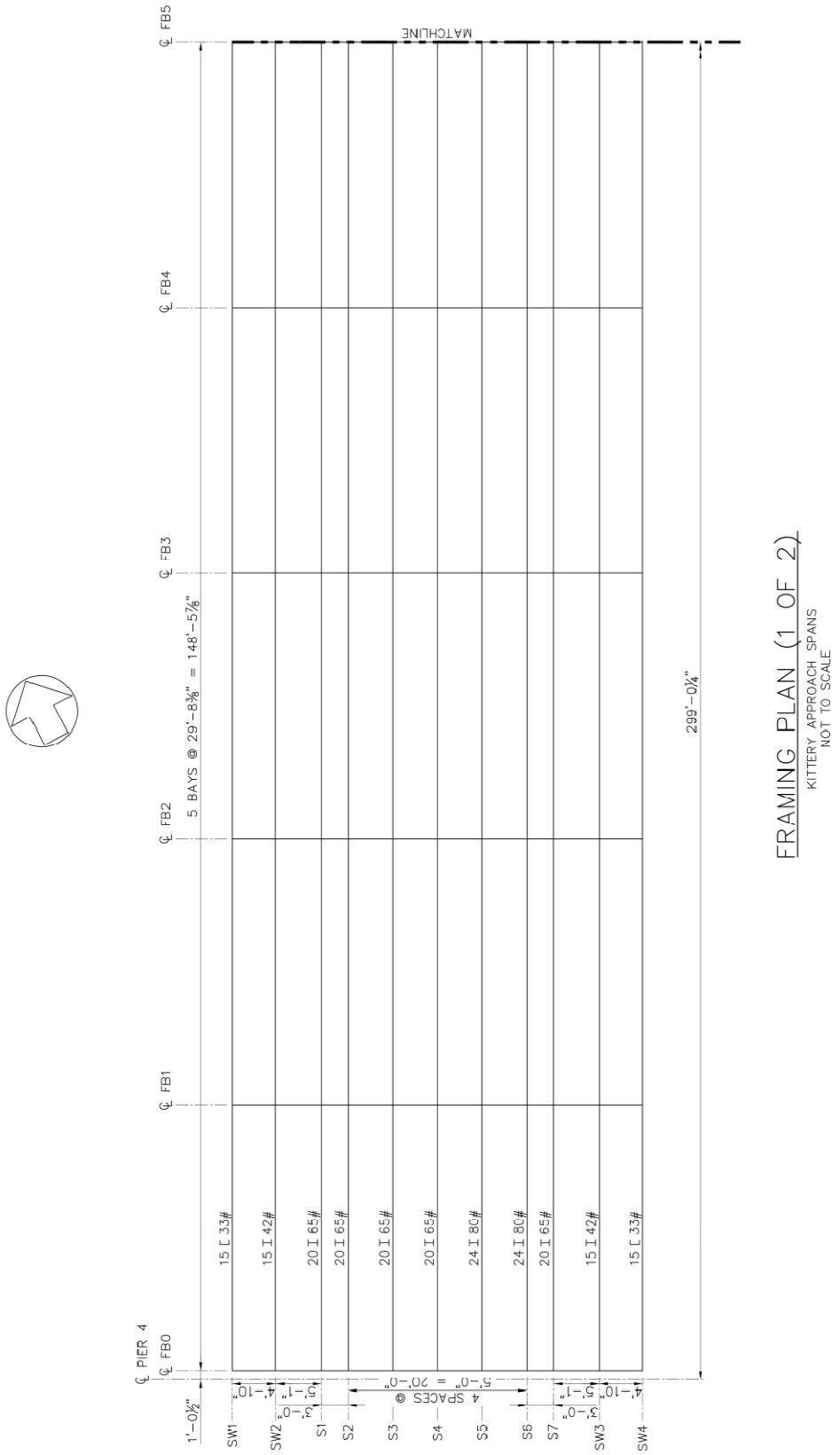
FIXED TRUSS SPANS 1 & 3



DECK FLOOR SYSTEM
PURLINS AND STRINGER BRACING EXLUDED FOR CLARITY

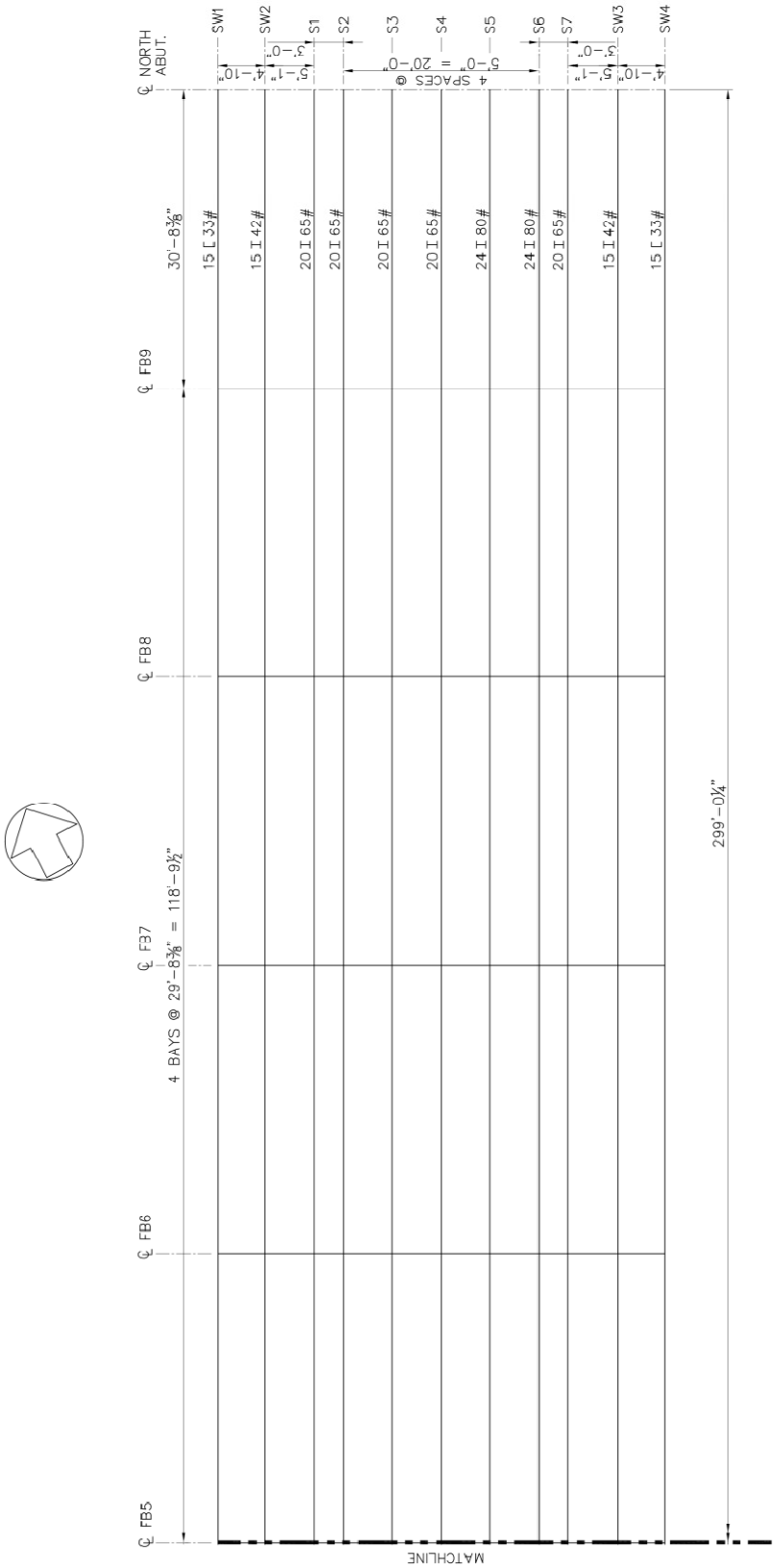
LIFT TRUSS SPAN 2

BRIDGE FRAMING PLAN



FRAMING PLAN (1 OF 2)
KITTERY APPROACH SPANS
NOT TO SCALE

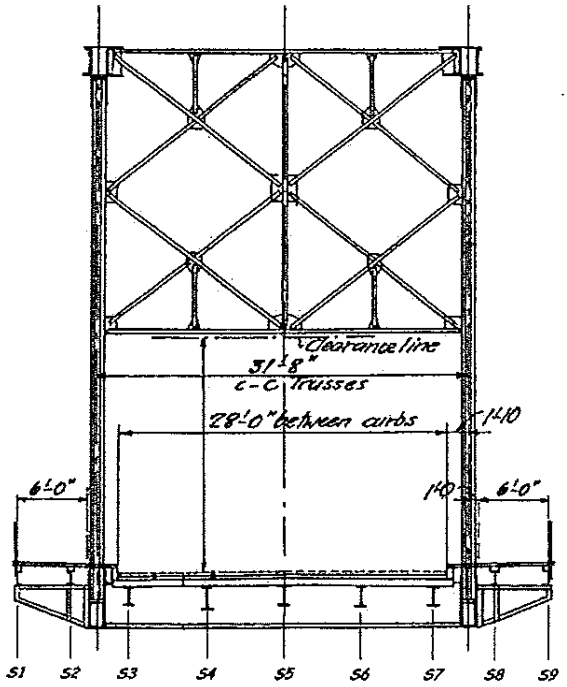
BRIDGE FRAMING PLAN



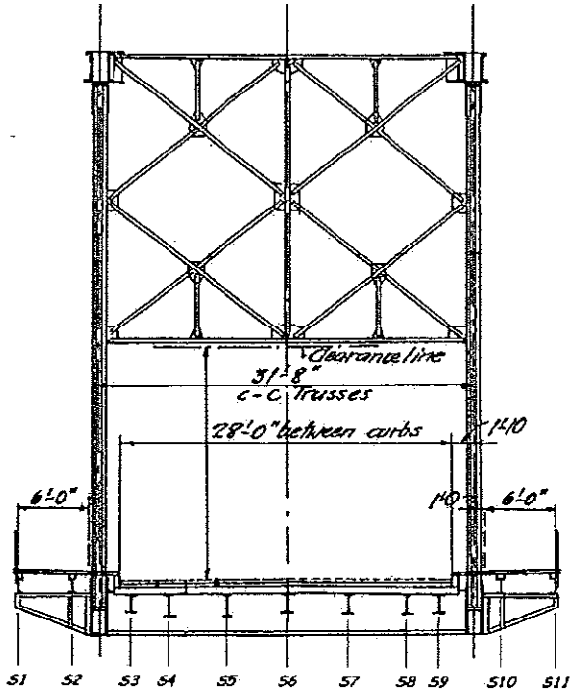
FRAMING PLAN (2 OF 2)

KITTERY APPROACH SPANS
NOT TO SCALE

TYPICAL BRIDGE CROSS SECTION

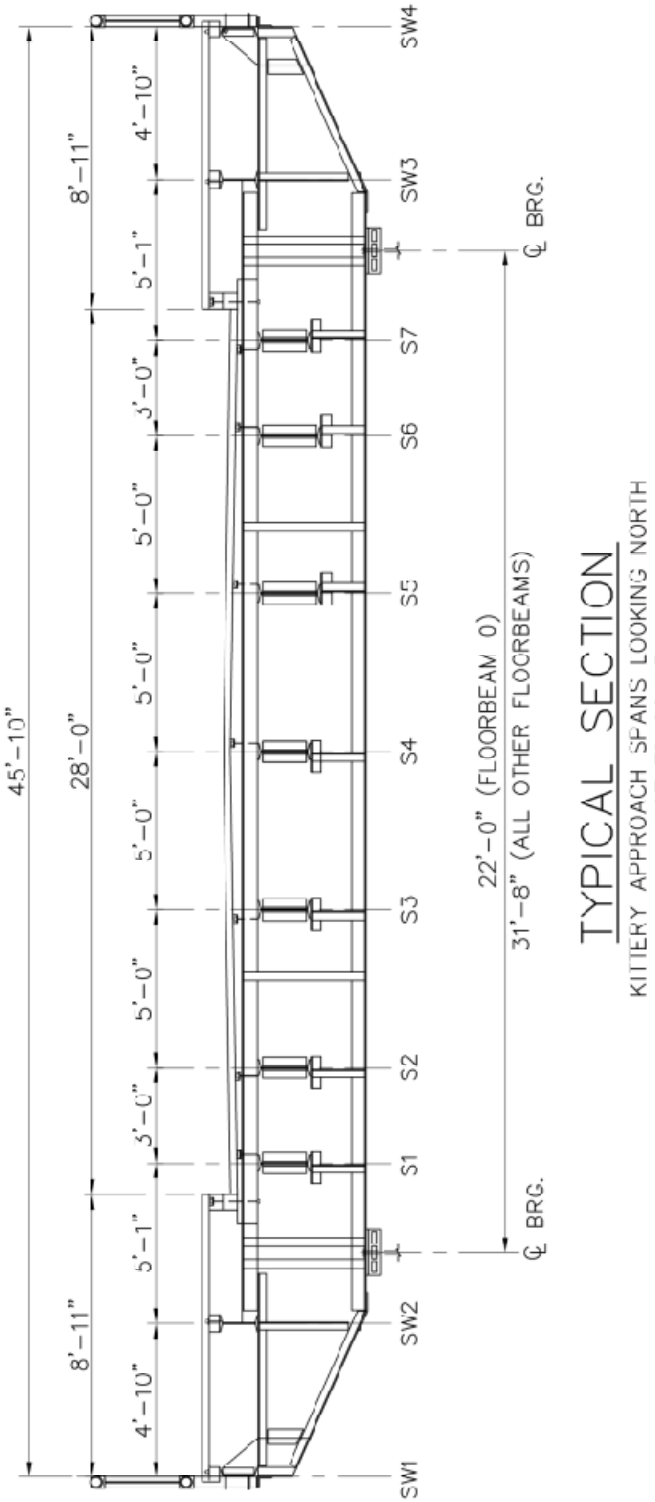


CROSS SECTION - FIXED TRUSS SPANS
(LOOKING NORTH)
N.T.S.



CROSS SECTION - LIFT SPAN
(LOOKING NORTH)
N.T.S.

TYPICAL BRIDGE CROSS SECTION



INSPECTION FINDINGS

INTRODUCTION

In May and June of 2009, HDR Engineering, Inc. (HDR) and Hoyle Tanner and Associates, Inc. (HTA) performed an in-depth inspection of the Portsmouth Memorial Bridge for the New Hampshire Department of Transportation. The inspection results are to be used to perform a load rating for the existing structure in its as-inspected condition and cost estimates for rehabilitation of the Portsmouth Memorial Bridge as part of the Bridge Inspection and Cost Analysis (BICA) study.

BRIDGE DESCRIPTION

The Portsmouth Memorial Bridge carries Route 1 over the Piscataqua River from Portsmouth, New Hampshire to Kittery, Maine. The structure is located in a tidal area where water elevation typically has an eight to twelve foot variation between high and low tide. The span-drive vertical lift bridge was built in 1922 and consists of three truss spans and ten approach spans. The truss spans are two Pratt-type, camelback, steel fixed through-trusses and a Pratt-type, straightback, steel center lift through-truss. The approach spans, referred to as the Kittery Approach, are comprised of ten multi-stringer and floorbeam approach spans on the north side of the structure. The lift span has an open steel grating deck and all other spans have a reinforced concrete deck. The roadway decks are supported by steel purlins. The sidewalk decks are comprised of timber planks supported by steel stringers. The truss spans are supported by reinforced concrete piers with granite facades. The approach spans are supported by a combination of circular and square reinforced concrete columns and a reinforced concrete abutment at the north end.

The truss spans are numbered 1 to 3 from south to north. Truss panel points and floorbeams are numbered from south to north with the southernmost panel point or floorbeam of each span designated as 0. The Kittery Approach Spans are numbered 1 to 10 from south to north. Kittery Approach stringers are numbered from west to east.

INSPECTION METHODS

Several inspection access methods were utilized to perform the in-depth inspection of the Memorial Bridge.

The Truss Spans' bottom chords, bottom gusset plates and the floor system (comprised of the bottom side of the deck as well as the floorbeams, stringers, bottom lateral bracing, stringer bracing, purlins and all their connections) were inspected utilizing a bucket boat. The bucket boat is a custom designed and constructed craft consisting of a 30' by 15' boat with pontoons and a 60' bucket.

The Truss Spans' diagonals, verticals, top chords and towers were inspected by industrial rope access. Structure climbing and the use of the vertical lift were used to access the top of the towers.

The Truss Spans' Piers were inspected utilizing a bucket boat, as well as underwater diving.

The Kittery Approach Spans were inspected using an under bridge inspection vehicle and land access to inspect the abutment and bases of the piers.

BRIDGE CONDITION

Item 58 – Overall Deck – Poor Condition

58.1: Deck

Steel Open Grating – Vertical Lift Truss Span: Surface rust is typical throughout the steel grating. Several sections of the steel open grating are loose. The traction grooves on the top of the grating are worn in some areas. Welds on the steel grates are of poor quality.

Reinforced Concrete – Fixed Truss Spans: Deck has hairline cracks and minor honeycombing throughout. Areas around metal downspouts have more severe honeycombing. The deck has been patched at PVC downspouts.

The deck is spalling in several locations, with exposed rebar. There is up to 50% section loss in rebar at a large spall located in Span 1, Bay 8 at the west end of Floorbeam FB8. Other locations with exposed rebar have minimal to no section loss.

Reinforced Concrete – Kittery Approach Spans: The concrete deck is in poor condition near the curblines and fair condition nearer to the interior roadway stringers. Deterioration is most severe adjacent to the scuppers. The deck is not in contact with the transverse purlins by ⅛" to ¼" in many locations. A squeaking noise caused by the deck coming into contact with the purlins under live load was noted during the inspection.

58.2 Wearing Surface:

The asphalt pavement wearing surface on the Fixed Truss Spans and Kittery Approach Spans was inspected visually and by the "chain drag" method. The inspection revealed localized areas of cracking and delamination, largely concentrated at the centerline of the roadway and at the curblines. Pavement cracking, delamination and distress was noted at each scupper location, but was more advanced along the southbound curbline. Settlement and previous repairs were noted along the north abutment expansion joint. Transverse cracks were noted at the centerline of the roadway and in some locations in the southbound lane.

58.3 Deck Joints:

North Abutment Joint: The concrete header on each side of the joint exhibits plow damage and surface wear. The strip seal is leaking to the stringer bearings on the abutment below.

Finger Joints: The finger-joint steel is in fair to good condition. There are no troughs below the joints, therefore, salt-laden water leaks directly onto the superstructure below.

58.4 Sidewalks:

The timber planks exhibit splits, checks and areas where the planks are loose. The concrete curbs have numerous longitudinal cracks at approximately half the reveal height which coincides with the location of the anchorage of the sidewalk support angle. Vegetation has grown through both sidewalks to the superstructure below near the Kittery Approach Span north abutment.

58.5 Bridge Rail:

Fixed and Vertical Lift Truss Spans: The vehicular bridge rail has surface rust and some laminar corrosion throughout. Corrosion holes were found in the rail and rail supports in many locations. The portion of the vehicular bridge rail supports located under the deck are typically corroded with

section loss in areas above truss bottom chords and at connections to sidewalk stringers, with corrosion holes in the webs of several supports. The pedestrian railing is typically rusted throughout, with corrosion holes in several locations. The pedestrian bridge rail is bolted to the exterior sidewalk stringers. Laminar corrosion on the pedestrian railing supports is typical.

Kittery Approach Spans: The rail on both sides is heavily rusted with component separation and holed areas throughout. Some areas exhibit 100% section loss, specifically, at the connections to the stringers. In many areas, the rails have separated from the rail posts. Significant rusting was noted at the rail post to stringer connections. Some previous repairs were noted.

58.6 Drainage:
Fixed Truss Spans: The fixed truss spans have both metal and PVC drain pipes underneath the deck. The PVC drain pipes were installed as replacements for some of the metal drains and are typically in fair condition. The remaining metal drains are severely corroded with up to 100% section loss on large portions of the drains. The metal drains terminate above the bottom flange of stringers, causing corrosion and section loss on the stringers. Due to corrosion holes, all structural components (purlins, deck, stringers, bottom chords) are exposed to water and corroded at the metal drain locations.

Kittery Approach Spans: The downspouts are typically heavily rusted and holed. Loss of section and holes have allowed salt-laden water to leak directly onto the curbline stringers leading to loss of bottom flange section of the stringers.

<u>Item 59 – Overall Superstructure – Serious Condition</u>

59.1 Purlins:
Vertical Lift Truss Span: Purlins have rust throughout on all surfaces. There is typical pack rust on bottom flanges at stringer connections. The purlins at the concrete to steel grate deck transition has pitting and rust throughout. The sixth purlin from the south end of Bay 10 has 100% section loss in the web at Stringer S6. Purlins are typically spliced at Stringer line S6. Bay 8 splices are missing bolts in several locations. Several purlins have bolted repairs spliced to webs in other locations. These repairs are installed on one purlin in Bay 4 at Stringer S8 and three purlins in Bay 7 at Stringer S4.

Fixed Truss Spans: Purlins are typically deteriorated with laminar corrosion at areas around downspouts and at the edge of deck. Downspouts are typically found at mid-span of Stringers S3 and S7. Corrosion on purlins is also found at the area around the downspout located in Span 3, Bay 1, Stringer S5, south end of stringer. Purlins are corroded on all faces at edge of deck with pack rust between the top flange and deck.

Purlins are in generally fair condition at all other areas, with some surface rust on all purlins.

Kittery Approach Spans: The purlins exhibit significant and serious deterioration around the downspouts and in other location near the curblines. Some sections have 100% loss of the web sections and extensive loss of the flanges as well. The purlins are spaced at 2'-5" to support the concrete deck, however, in many locations there is a ⅛" to ¼" gap between the top flange and bottom of the deck.

59.2 Stringers:
Vertical Lift Truss Span: Roadway stringers are in generally serious condition with corrosion and section loss throughout. Many stringers have corrosion holes in webs and partial widths of flanges with 100% section loss. Roadway Stringer lines S4, S5, S7 and S8 are generally the most deteriorated. Many of the roadway stringers are repaired with bolted channels and plates.

Sidewalk Stringer lines S2 and S10 have rust throughout and pack rust at connections to the bridge barrier supports. Sidewalk Stringer lines S1 and S11 have surface rust throughout and pack rust at bridge railing connections.

Fixed Truss Spans: The inside roadway stringers, Stringer lines S4, S5 and S6 are in typically fair condition with paint peeling and some surface rust throughout. Bay 10 Stringers S4 and S5 have corrosion near Floorbeam FB9. Outside roadway Stringer lines S3 and S7 are typically deteriorated at downspouts, which are approximately located at stringer midspan. Typical deterioration at downspouts consists of laminar corrosion and section loss on all surfaces, as well as web corrosion holes at Stringers S7 in Span 1, Bay 4 and Span 3, Bay 7.

Sidewalk Stringer lines S2 and S8 have rust throughout and pack rust at connections to the bridge barrier supports. Sidewalk Stringer lines S1 and S9 have surface rust throughout and pack rust at bridge railing connections.

Kittery Approach Spans: The interior roadway stringers S2, S3 and S4 of spans 1 through 9 are considered to be in good condition with no serious deficiencies were observed. The interior roadway stringers of span 10 exhibit flange and web section loss at the abutment bearings due expansion joint leakage above. Exterior roadway stringers S1 and S7 are considered to be in poor condition with top and bottom flange section losses observed throughout the structure. Extensive section losses were observed in the areas of the downspouts. The webs of the exterior roadway stringers in span 10 have been previously repaired with welded plates.

59.3 Floorbeams:
Vertical Lift Truss Span: Floorbeams typically have corrosion with section loss on both flanges and webs. The majority of floorbeams have several corrosion holes throughout, with the largest being 16" wide. The largest web holes are generally located adjacent to stringer connections and at floorbeam ends. Floorbeams FB1, FB3-FB6, FB8 and FB9 have repair plates spliced to the webs, with several of the splices welded to tension areas of the floorbeams.

Floorbeam overhangs are typically rusted and corroded at truss connection, with deterioration in webs and top flanges. Corrosion holes are typical at bottom of web at the connection angle to truss or at the vertical web stiffener angle.

Fixed Truss Spans: Truss Spans 1 and 3 floorbeams typically have laminar corrosion, pitting on bottom of web and bottom flange at floorbeam ends. Several floorbeams have corrosion holes in the same location. Between Stringers S3 and S7, floorbeams typically have some surface rust on flanges and web.

There are several welds in the tension zones of the floorbeams, which are fracture critical. Repair plates are welded to the webs of Span 3, Floorbeams FB7 and FB9 and Span 1, Floorbeam FB3 at floorbeam ends. A steel plate with an unknown purpose is welded to Span 1, Floorbeam FB0 at the

pier. This plate is oriented perpendicular to the web, welded to the tension zone of the web and has a flame-cut hole with uneven surfaces.

At the deck joints, there are deck overhang supports riveted to the webs of the end floorbeams (Floorbeams FB0 and FB10 in each span). These supports are severely deteriorated with up to 100% section loss on Span 3, Floorbeam FB10. There are welded repairs to the supports at Span 1, Floorbeam FB0.

Kittery Approach Spans: Each floorbeam exhibits scaling, section loss and failure of the coating system. Top flange and web deterioration is most severe near the bearings at the curblines where section loss varies from 50% to 100% in some areas. Web holes up to 5" in diameter were observed in several floorbeams. Floorbeam 0 (FB0), at pier 4 of the truss spans, is considered to be in poor to serious condition. The other floorbeams are considered to be in poor condition. The following deficiencies were observed:

- Web holes above exterior roadway stringer connections.
- Web surface rusting, pitting and scaling.
- Heavy rusting of top flange angles near curb lines.
- 50% to 100% top flange angle section loss.
- Cantilevered sidewalk support top flange angle section loss up to 100%.
- Holes in webs of cantilevered sidewalk supports.
- Minor corrosion and section loss of bottom flange angles.
- Web holes, ranging from ½" to 5" in diameter, near bearing locations (FB0, FB2, FB3)

59.4 Truss Members:
Truss bottom chord members typically have deterioration with section loss at the gusset plates and some surface rust throughout webs and top flanges. Some chords have significant deterioration for the full-length of the bay. Bottom chord lacing bars and gusset plates are typically deteriorated, with 100% section loss in several locations. On several bottom chord members, batten plates are welded to the chord flanges.

Truss diagonals and verticals typically have corrosion and section loss at the lower gusset connections. Span 2 verticals and diagonals connected to the operator house supports and stairwell have corrosion at those locations. Several verticals and diagonals have flange splices installed. These splices are bolted on the verticals, but several are welded to the diagonals. Diagonals have pitting at or above deck level and severe corrosion on some batten plates adjacent to the bottom chord. There are corrosion holes on two Span 1 east truss diagonals. These corrosion holes are on the web of member U1-L2 and on the flange of member L0-U1. Several verticals and some diagonals have welded batten plates near the bottom chord.

Top chords typically have laminar corrosion and pitting on the top flange plate and at sway frame connections. There is rivet head section loss the full-length of all top chords in all bays, with up to 90% of the rivet heads having section loss in some bays.

59.5 Towers:
Tower gusset plates typically have pitting and pack rust at member interfaces, causing several gusset plates to bulge. Several gusset plates and knee braces have corrosion holes. Horizontal tower members have laminar corrosion and section loss at gusset connections. The flange plates of

the southeast column of the North Tower are bowing between panel points T0 and T1. There is surface rust and paint loss throughout all tower members.

59.6 Bearings:
Fixed Truss Span:

Span 1 South Bearings (expansion - at Pier 1) have laminar corrosion between the bearing pin and the superstructure, as well as pack rust between the gusset plates bearing on the pin and section loss on those plates. The rocker bearing was in a near-vertical position at the time of inspection.

Span 1 North Bearings (fixed – at Pier 2) have tar-like debris in and around the bearings. The bearing pins have some pitting.

Vertical Lift Truss Span:

Span 2 South Bearing (fixed – at Pier 2) have pitting on the bearing pin and plates. This bearing consists of a bearing plate that lifts with the superstructure, and a base plate that the bearing plate sits on when the lift span is in its lowered position. At the time of inspection, the front of the bearing plate was set 1.125" back from the front of the base plate. The gusset plate bearing on the pin has pack rust and is welded. There is pigeon debris inside of the bearing assemblies.

Span 2 North Bearings (expansion - at Pier 3) have laminar corrosion between the bearing pin and the superstructure gusset bearing on the pin. There is pack rust between the pin cap and vertical bearing plate. The rocker bearing was in a near-vertical position at the time of inspection, only slightly tilted back.

Fixed Truss Span:

Span 3 South Bearings (fixed – at Pier 3) have tar-like debris in and around the bearings. There is also pigeon debris inside the bearing assemblies. There is surface rust and some pitting on the bearing, as well as corrosion on the pin. The northern anchor bolts are bent forward.

Span 3 North Bearings (at Pier 4) have laminar corrosion between the bearing pin and the superstructure gusset bearing on the pin. There is surface rust and bleeding between the pin cap and vertical bearing plate. The rocker bearing was in a near-vertical position at time of inspection.

Kittery Approach Spans: In numerous locations, anchor bolts exhibit up to 100% section loss. In general, the bearings are heavily rusted with varying amounts of section loss.

59.7 Connections and Plates:
Truss Spans: Truss gusset plates are in generally serious condition. Most plates have laminar corrosion with section loss and corrosion holes. Many plates have welded or bolted repair plates on a portion of the gusset plate. These partial repairs are either of poor quality or have corroded. Several gusset plates have been retrofit since the 2003 inspection with additional plates. These plates are located at Span 1 – L4W, L4E and L6E, Span 2 – L2E, L6E, L6W, and Span 3 – L6W, L6E, L8W.

Several floorbeam connections to fixed span trusses are moderately deteriorated with section loss. All floorbeam connections to the vertical lift span trusses are deteriorated with section loss.

Several fixed span stringer connection angles have pitting and some laminar corrosion. The east steel angle connecting Span 1, Bay 7 Stringer S7 to Floorbeam FB6 has a 12 $^{7}/_{8}$" crack along the angle corner. Vertical lift span stringer connections typically have laminar corrosion and pitting.

Kittery Approach Spans: Connection plates between the cantilevered sidewalk sections and roadway floorbeams are severely corroded and the rivet heads exhibit 50% to 100% section loss. Connections between the exterior roadway stringers and floorbeams are severely deteriorated. Connections between the interior roadway stringers and floorbeams are in fair condition; however, there are holes through the floorbeam webs below the angle-seat connections.

59.8 Bracing:
Truss Spans – General: Sidewalk stringer bracing is typically rusted and corroded throughout. Sidewalk stringer bracing gusset plates have laminar corrosion with section loss.

Deterioration of top lateral bracing typically occurs at the gusset plates connecting the bracing to the truss. There is pack rust at the truss and bracing connections on the gusset plates. Sway frames typically have surface rust and pitting throughout. Several sway frames have corrosion holes on the bottom struts and pack rust at the center gusset plates. Multiple sway frames have collision damage on the bottom struts.

Vertical Lift Truss Span: Stringer bracing is typically rusted and corroded throughout. Many of the stringer bracing members have been replaced in Bays 1, 3, 4, 5 and 6. Stringer bracing gusset plates typically have laminar corrosion and section loss.

Lower lateral bracing is corroded throughout. Horizontal legs have 100% section loss on several lateral bracing members. Lateral gusset plates typically have corrosion with section loss.

Fixed Truss Spans:

Lower lateral bracing has rust and laminar corrosion on several members. Several members have been repaired with bolted splices. Many lower lateral gusset plates have been previously replaced but, similar to the remaining original plates, have corrosion and section loss. There are corrosion holes in several lateral gusset plates.

Kittery Approach Spans: The lateral bracing under the sidewalks is in serious condition. Numerous sections of the bracing have failed and fallen into the river. The remaining bracing members are near failure with 100% connection plate section loss.

<u>Item 59 – Overall Substructure – Fair Condition</u>

62.1 Abutments:

Kittery Approach Spans Maine Abutment: The concrete abutment exhibits extensive spalling, cracking, efflorescence and deterioration throughout the stem, backwall and wingwalls. A 3/16" wide vertical crack extending from finished grade to the beam seat was noted at the approximate bridge centerline. Approximately 3/16" in differential settlement between the west and east halves of the bridge was observed on each side of the crack.

62.2 Piers:

Vertical Lift and Fixed Truss Spans:

Pier 1 has a large full-height crack on the concrete portion, and large spalls on the pedestal for the Scott Avenue Bridge (Bridge 246/083).

Piers 2 and 3 have full-height cracks with efflorescence as well as horizontal cracks across the piers. Pier 2 has web cracking with efflorescence in pier cap underneath the southeast bearing of Span 2.

The pier cap of Pier 4 has significant spalling with medium to large cracks throughout. There are circular patches on the horizontal face of the cap underneath the west bearing, possibly indicating that there previously were conical-shaped pop-outs.

Refer to the report entitled "Underwater Inspection of Memorial Bridge and Sarah Mildred Long Bridge" by Appledore Marine Engineering, Inc. for the condition of underwater portions of the piers.

Kittery Approach Spans:

All but four of the original rectangle pier columns were replaced with 3' diameter circular concrete columns as part of the 1986 bridge rehabilitation. Of the original rectangular columns, the following was noted:

Pier 9W – Generally sound, minor cracking.

Pier 8W – 1/8" crack at the northwest corner, minor spalling and efflorescence. Extensive cracking on north and west faces.

Pier 8E – Moderate amount of cracking on south and east faces with minor spalls.

Pier 6W – No significant deficiencies noted.

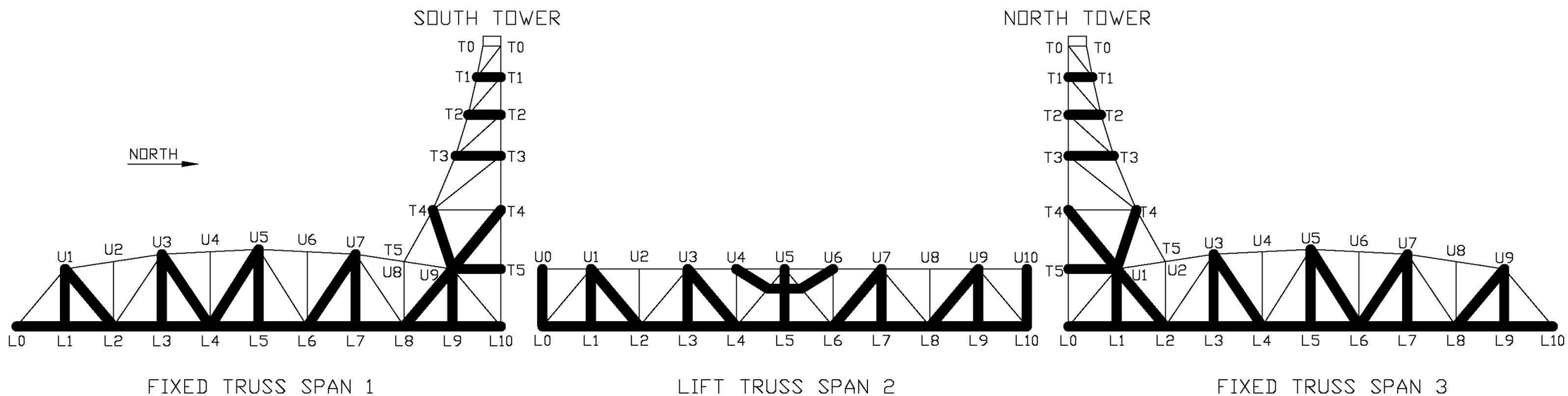
The circular replacement piers were generally found to be in good condition with minor cracking. No significant deficiencies were found in the circular piers.

FRACTURE CRITICAL INSPECTION

IDENTIFICATION OF FRACTURE CRITICAL MEMBERS

Type of FCM:	Quantity:
Steel Riveted Built-Up Floorbeams and Cross Girders	43
Steel Riveted Truss Bottom Chords	60
Steel Riveted Truss Diagonals	28
Steel Riveted Truss Verticals	34
Steel Riveted Truss Web Members at Control House	20
Steel Riveted Tower Truss Members	24

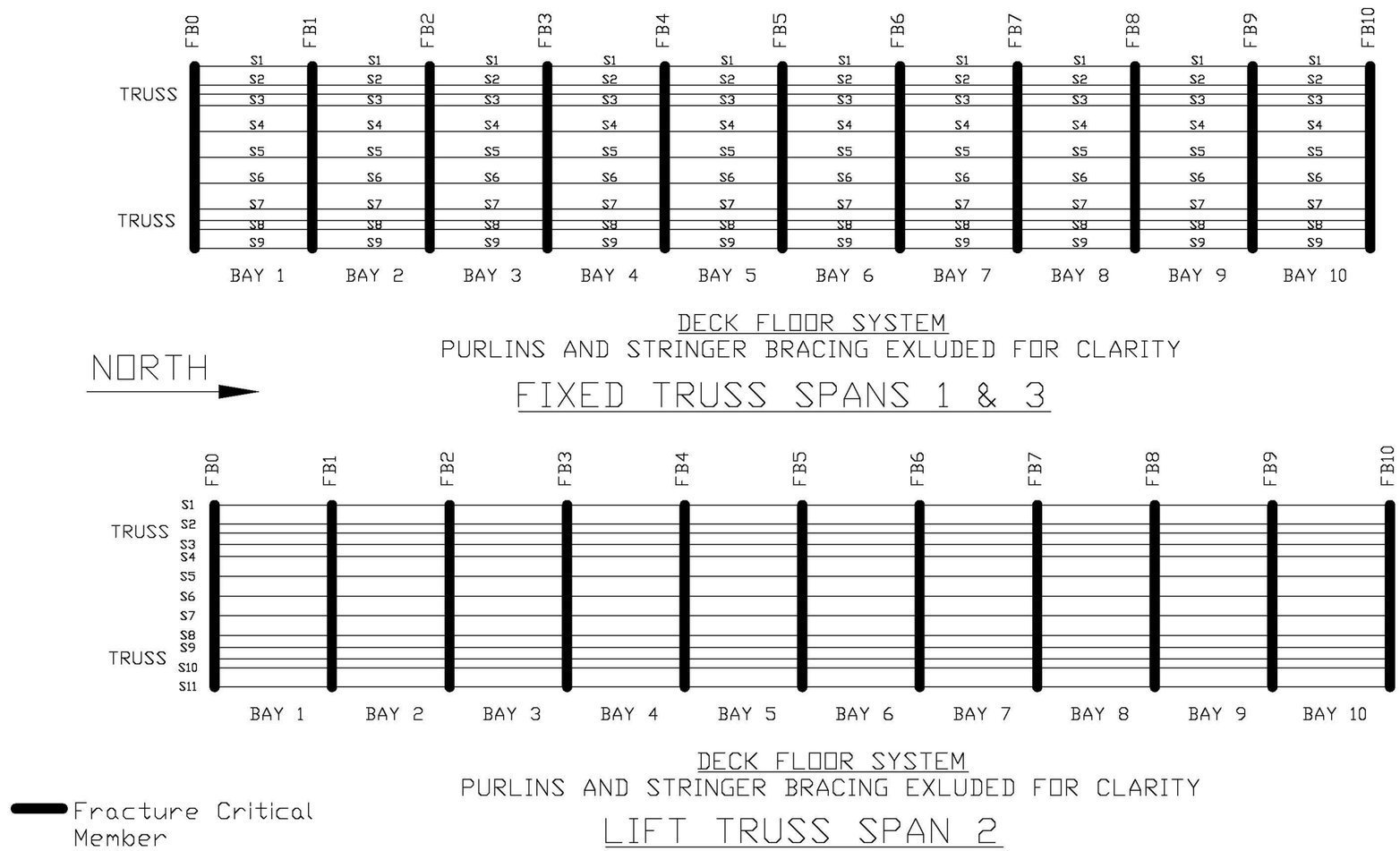
IDENTIFICATION OF FRACTURE CRITICAL MEMBERS



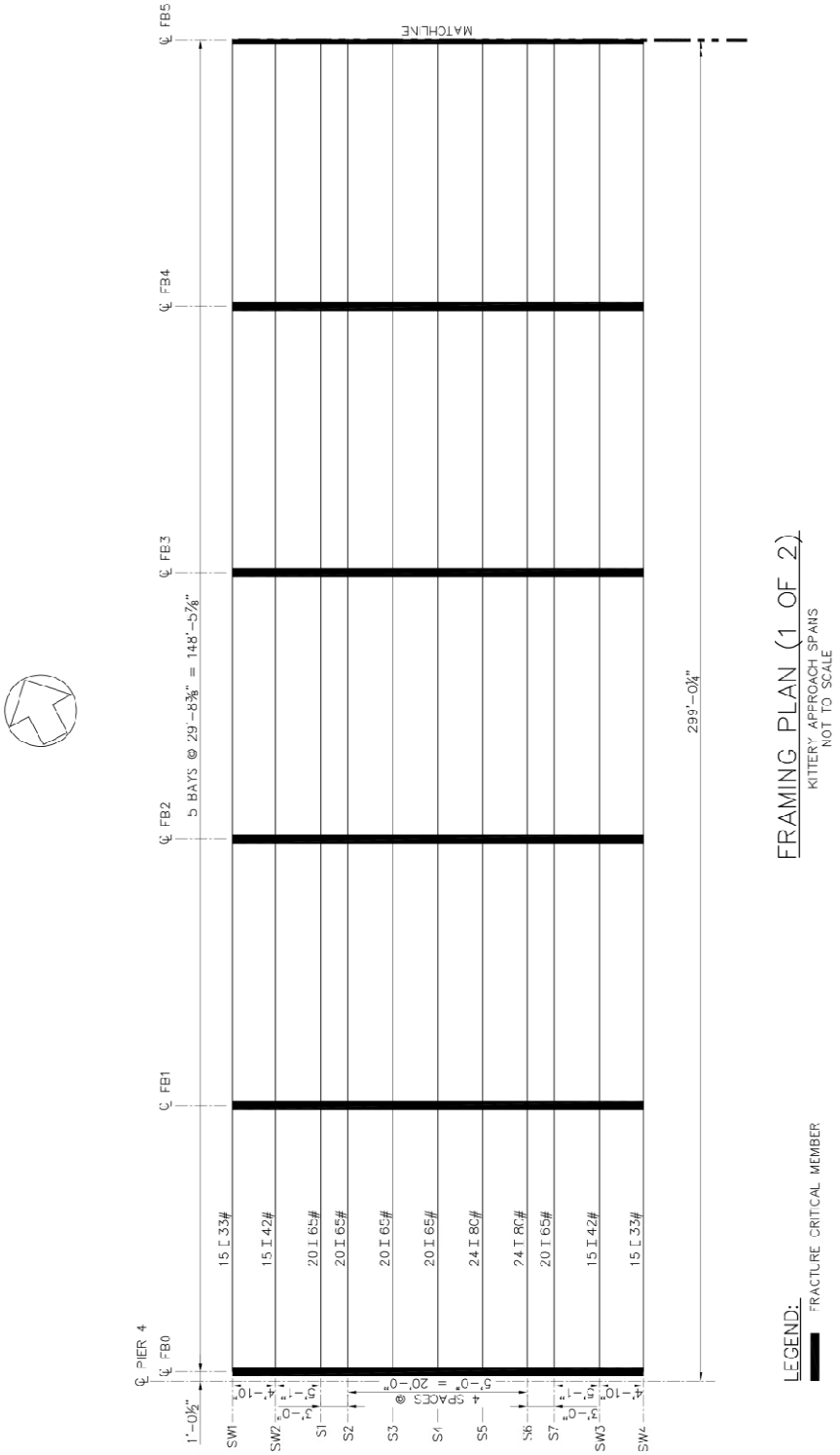
Fracture Critical Member

MEMORIAL BRIDGE ELEVATION

IDENTIFICATION OF FRACTURE CRITICAL MEMBERS



IDENTIFICATION OF FRACTURE CRITICAL MEMBERS



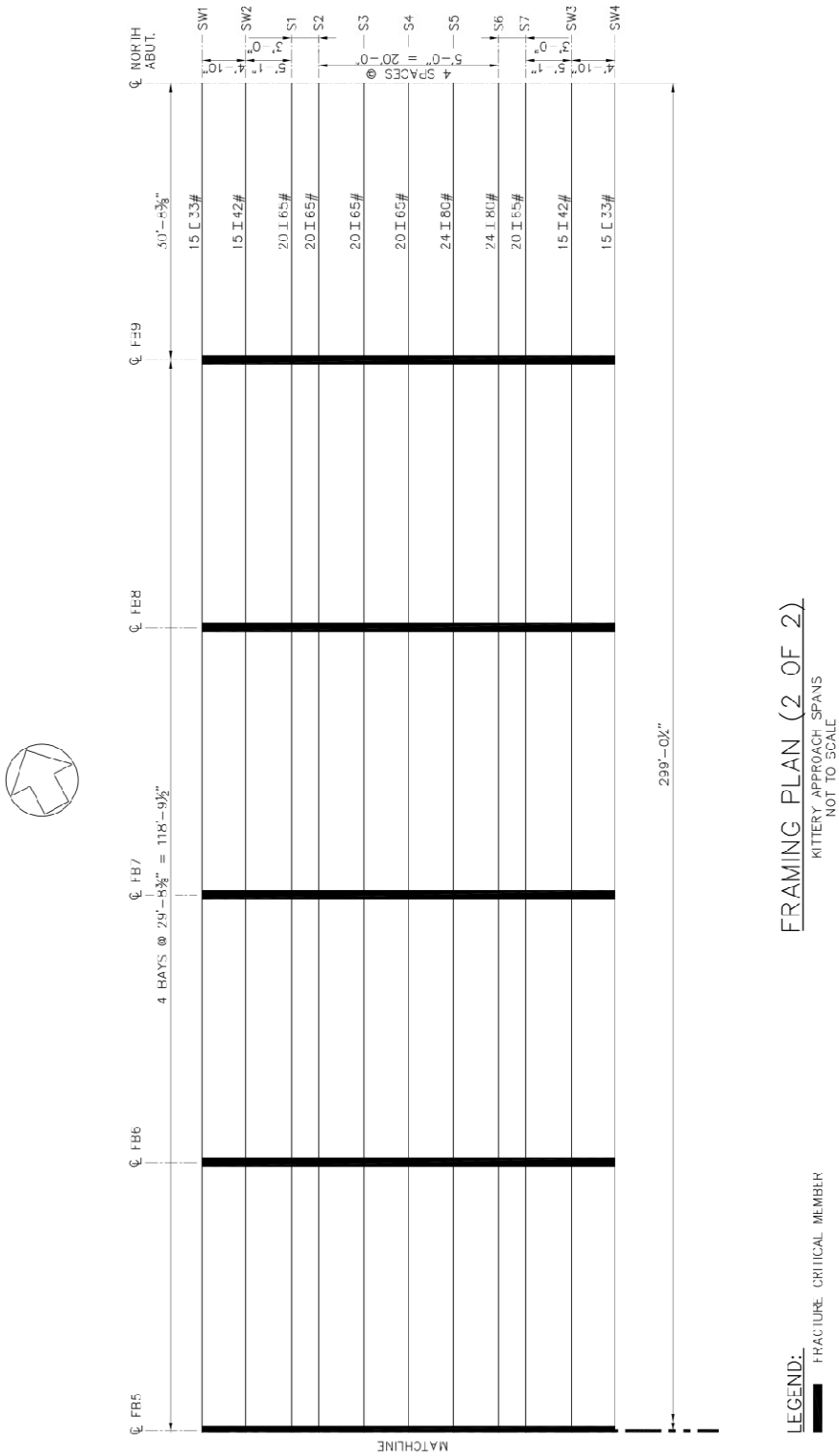
FRAMING PLAN (1 OF 2)

KITTERY APPROACH SPANS
NOT TO SCALE

LEGEND:

FRACTURE CRITICAL MEMBER

IDENTIFICATION OF FRACTURE CRITICAL MEMBERS



FRACTURE CRITICAL INSPECTION PROCEDURES

Steel Riveted Built-Up Floorbeams and Cross Girders:

1. Check all rivets and bolts to determine that they are tight and that the individual components are operating as one. Check for cracked or missing bolts, rivets and rivet heads

   Findings: Although rivet heads have section losses in many locations, all individual components are operating as one.

2. Check the member for misplaced holes or repaired holes that have been filled with weld metal. These are possible sources of fatigue cracking.

   Findings: There are numerous holes drilled for web repair. These holes were covered by repair plates or by washers and bolts. No cracks were observed outside of the area covered by washers at the hole locations.

3. Check the area around the floorbeam and lateral bracing connections for cracking in the web due to out-of-plane bending.

   Findings: Floorbeams do not have lateral bracing connections. There is severe section loss in the floorbeam webs at the floorbeam end connections. No cracks were found in the webs due to out-of-plane bending.

4. Check the entire length of the tension flanges and web for cracking, which may have originated from corrosion, pitting, section loss, or defects in fabrication (e.g., nicks and gouges in the steel).

   Findings: There is extensive corrosion, pitting and section loss on the floorbeam webs and tension flanges. There are corrosion holes in the webs at several locations. No cracks propagating from corrosion were found.

5. Check the entire length of temporary erection welds, tack welds, welded connections not shown on the design drawings or other miscellaneous welds used in either construction or repair as these are possible sources of cracks.

   Findings: The floorbeams have several repair plates welded to tension zones. No cracks were found propagating from these welds.

Steel Riveted Truss and Tower Members:

1. Check each component to see that the loads are being evenly distributed between them by attempting to vibrate the member by hand, and that batten plates and lacing are tight.

   Findings: Although rivet heads have section losses in many locations, all individual components are operating as one.

2. Check carefully along the first row of rivets for cracking as the first row carries more load than succeeding rows. The first row is the row closest to the edge of the gusset plate and perpendicular to the axis of the member.

   Findings: No cracks were observed.

3. Check of nicks, gouges and tears due to the impact from passing vehicular or marine traffic. This type of damage can initiate future cracks.

   Findings: No nicks, gouges and tears were observed.

4. Observe carefully any tack welding used either in construction or repair as this is a potential source of cracks. Any tack welds should be flagged to the attention of the bridge engineer in the report for future observation and consideration in stress rating.

   Findings: There are several locations with welded repairs, including several welded plates at gusset plates, welded repair plates to webs of verticals and diagonals and welded batten plates to bottom chord members. No cracks were observed at repair welds.

5. If any misplaced holes or holes used for reconstruction have been plug welded, check carefully for fatigue cracks.

   Findings: There are numerous holes drilled for web repair in bottom chord gusset plates. These holes were covered by repair plates or by washers and bolts. No cracks were observed outside of the area covered by washers at the hole locations.

IDENTIFICATION OF FATIGUE SENSITIVE DETAILS (FSD)

FSD 6 - Flexural stress on the toe of transverse welds on girder webs or flanges:

The toe of vertical welds for web repair plates on floorbeams.

FSD 14 - Base metal at details connected with transversely loaded welds, with the welds perpendicular to the direction of stress:

The bottom of the tension diagonals where the gusset plates are welded to diagonals. The top flanges of bottom chords where batten plates are welded.

FSD 15 - Base metal adjacent to details attached by groove welds in the direction of stress:

Tension verticals where web repair plates are welded to the flange angles. Floorbeam web repairs where the plates are welded to the flange angles.

FSD 17 - Base metal adjacent to details attached by longitudinally loaded fillet welds:

Base metal at horizontal fillet welds for web repair plates on floorbeams. Truss tension verticals and diagonals where gusset plates are welded to the flanges. Truss tension verticals where batten plates were welded to the angles. The top flanges of bottom chords where batten plates are welded.

FSD 21 - Base metal at net section of riveted connections:

All fracture critical members.

Quantity of FSD Types: 5

IDENTIFICATION OF FATIGUE SENSITIVE DETAILS (FSD)

General Condition	Situation	Detail Category	Illustrative Example; See Figure 6.6.1.2.3-1
Plain Members	Base metal:		1, 2
	• With rolled or cleaned surfaces; flame-cut edges with *AASHTO/AWS D1.5M/D1.5* (Section 3.2.2) smoothness of 1,000 μ-in. or less	A	
	• Of unpainted weathering steel, all grades, designed and detailed in accordance with FHWA (*1989*)	B	
	• At net section of eyebar heads and pin plates	E	
Builtup Members	Base metal and weld metal in components, without attachments, connected by:		3, 4, 5, 7
	• Continuous full-penetration groove welds with backing bars removed, or	B	
	• Continuous fillet welds parallel to the direction of applied stress	B	
	• Continuous full-penetration groove welds with backing bars in place, or	B′	
	• Continuous partial-penetration groove welds parallel to the direction of applied stress	B′	
	Base metal at ends of partial-length cover plates:		
	• With bolted slip-critical end connections	B	22
	• Narrower than the flange, with or without end welds, or wider than the flange with end welds ○ flange thickness ≤0.8 in. ○ flange thickness >0.8 in.	 E E′	7
	• Wider than the flange without end welds	E′	
Groove-Welded Splice Connections with Weld Soundness Established by NDT and All Required Grinding in the Direction of the Applied Stresses	Base metal and weld metal at full-penetration groove-welded splices:		
	• Of plates of similar cross-sections with welds ground flush	B	8, 10
	• With 2.0 ft. radius transitions in width with welds ground flush	B	13
	• With transitions in width or thickness with welds ground to provide slopes no steeper than 1.0 to 2.5 ○ grades 100/100W base metal ○ other base metal grades	 B′ B	11, 12
	• With or without transitions having slopes no greater than 1.0 to 2.5 when weld reinforcement is not removed	C	8, 10, 11, 12

From AASHTO LRFD Bridge Specifications, 4th Edition, Table 6.1.2.3-1

IDENTIFICATION OF FATIGUE SENSITIVE DETAILS (FSD)

General Condition	Situation	Detail Category	Illustrative Example; See Figure 6.6.1.2.3-1
Longitudinally Loaded Groove-Welded Attachments	Base metal at details attached by full- or partial-penetration groove welds:		
	• When the detail length in the direction of applied stress is:		
	○ less than 2.0 in.	C	6, 15
	○ between 2.0 in. and 12 times the detail thickness, but less than 4.0 in.	D	15
	○ greater than either 12 times the detail thickness or 4.0 in.		
	—detail thickness <1.0 in.	E	15
	—detail thickness ≥1.0 in.	E′	15
	• With a transition radius with the end welds ground smooth, regardless of detail length:		16
	○ transition radius ≥24.0 in.	B	
	○ 24.0 in. > transition radius ≥ 6.0 in.	C	
	○ 6.0 in. > transition radius ≥ 2.0 in.	D	
	○ transition radius <2.0 in.	E	
	• With a transition radius with end welds not ground smooth	E	16
Transversely Loaded Groove-Welded Attachments with Weld Soundness Established by NDT and All Required grinding Transverse to the Direction of Stress	Base metal at detail attached by full-penetration groove welds with a transition radius:		16
	• With equal plate thickness and weld reinforcement removed:		
	○ transition radius ≥24.0 in.	B	
	○ 24.0 in. > transition radius ≥ 6.0 in.	C	
	○ 6.0 in. > transition radius ≥ 2.0 in.	D	
	○ transition radius <2.0 in.	E	
	• With equal plate thickness and weld reinforcement not removed:		
	○ transition radius ≥6.0 in.	C	
	○ 6.0 in. > transition radius ≥ 2.0 in.	D	
	○ transition radius <2.0 in.	E	
	• With unequal plate thickness and weld reinforcement removed:		
	○ transition radius ≥2.0 in.	D	
	○ transition radius <2.0 in.	E	
	• For any transition radius with unequal plate thickness and weld reinforcement not removed	E	
Fillet-Welded Connections with Welds Normal to the Direction of Stress	Base metal:		
	• At details other than transverse stiffener-to-flange or transverse stiffener-to-web connections	Lesser of C or Eq. 6.6.1.2.5-3	14
	• At the toe of transverse stiffener-to-flange and transverse stiffener-to-web welds	C′	6
Fillet-Welded Connections with Welds Normal and/or Parallel to the Direction of Stress	Shear stress on the weld throat Base metal at end of weld	E	9

From AASHTO LRFD Bridge Specifications, 4th Edition, Table 6.1.2.3-1

IDENTIFICATION OF FATIGUE SENSITIVE DETAILS (FSD)

General Condition	Situation	Detail Category	Illustrative Example; See Figure 6.6.1.2.3-1
Longitudinally Loaded Fillet-Welded Attachments	Base metal at details attached by fillet welds:		
	• When the detail length in the direction of applied stress is:		
	○ less than 2.0 in. or stud-type shear connectors	C	15, 17, 18, 20
	○ between 2.0 in. and 12 times the detail thickness, but less than 4.0 in.	D	15, 17
	○ greater than either 12 times the detail thickness or 4.0 in.		7, 9, 15, 17
	—detail thickness <1.0 in.	E	
	—detail thickness ≥1.0 in.	E′	
	• With a transition radius with the end welds ground smooth, regardless of detail length		16
	○ transition radius ≥2.0 in.	D	
	○ transition radius <2.0 in.	E	
	• With a transition radius with end welds not ground smooth	E	16
Transversely Loaded Fillet-Welded Attachments with Welds Parallel to the Direction of Primary Stress	Base metal at details attached by fillet welds:		16
	• With a transition radius with end welds ground smooth:		
	○ transition radius ≥2.0 in.	D	
	○ transition radius <2.0 in.	E	
	• With any transition radius with end welds not ground smooth	E	
Mechanically Fastened Connections	Base metal:		21
	• At gross section of high-strength bolted slip-critical connections, except axially loaded joints in which out-of-plane bending is induced in connected materials	B	
	• At net section of high-strength bolted nonslip-critical connections	B	
	• At net section of riveted connections	D	
Eyebar or Pin Plates	Base metal at the net section of eyebar head, or pin plate	E	23, 24
	Base metal in the shank of eyebars, or through the gross section of pin plates with:		
	• Rolled or smoothly ground surfaces	A	23, 24
	• Flame-cut edges	B	23, 24

From AASHTO LRFD Bridge Specifications, 4th Edition, Table 6.1.2.3-1

IDENTIFICATION OF FATIGUE SENSITIVE DETAILS (FSD)

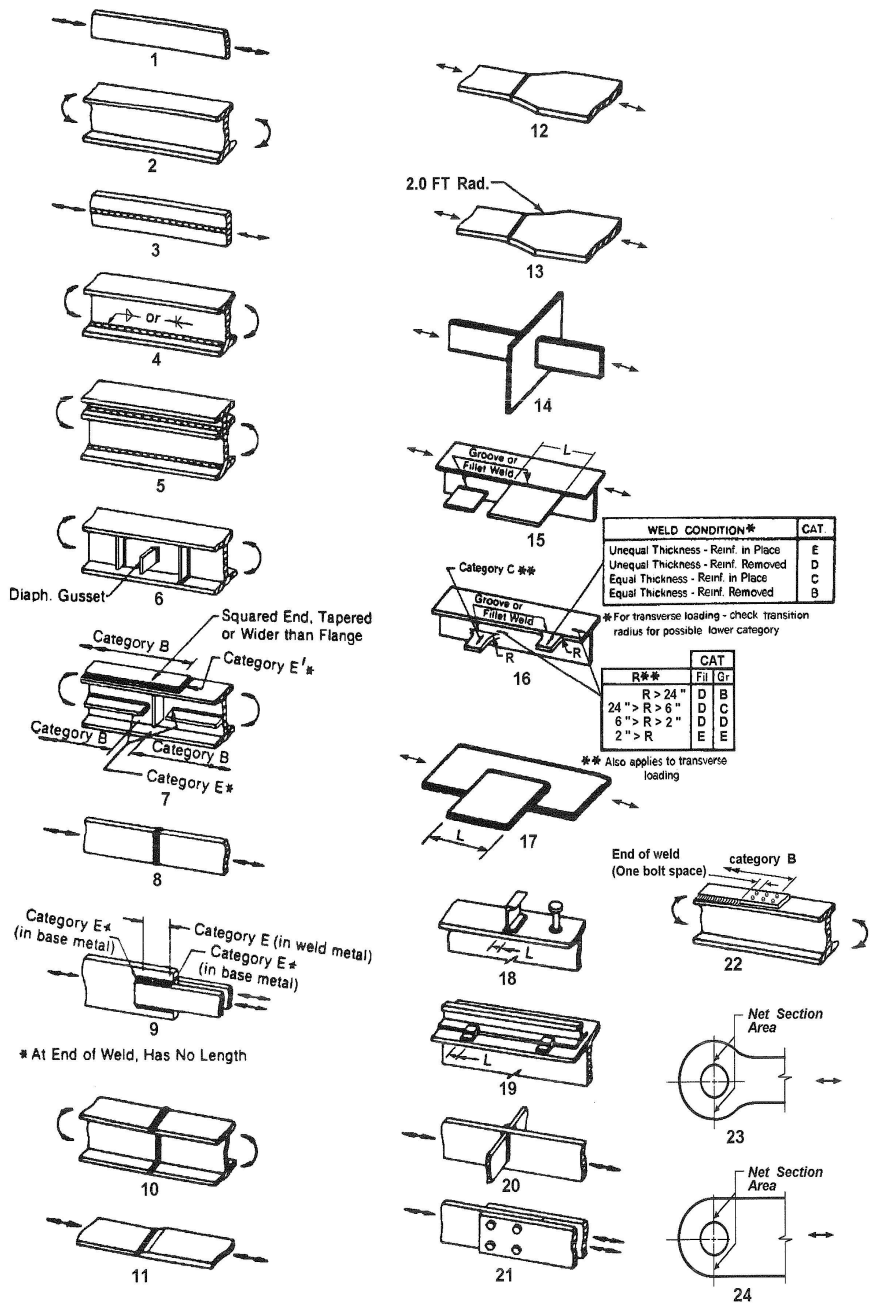


Figure 6.6.1.2.3-1 Illustrative Examples.

From AASHTO LRFD Bridge Specifications, 4th Edition, Table 6.1.2.3-1

APPENDICES

Appendix A: Inspection Forms

Appendix B: Photos

Part I – Truss Spans

Part II – Approach Spans

Appendix C: Condition Summary Tables and Sketches

Part I – Truss Spans

Section A: Truss Member Condition

Section B: Gusset Plate Condition

Section C: Truss Bracing and Bracing Gusset Plate Condition

Section D: Stringer Condition

Section E: Floorbeam Condition

Section F: Tower Condition

Part II – Kittery Approach Spans

Section A: Floorbeam Condition

Section B: Stringer Condition