

# Bridge Basics 101

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NORTH DAKOTA LOCAL TECHNICAL ASSISTANCE PROGRAM

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## Bridges are . . .

- A Valuable and Critical Asset
  - Major Rehabilitation or Replacement is Costly
  - Detour Routes are often Long
- The Link that Connects the Roadways in our Transportation System



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Murna Hauck – North Dakota Township Officer – “When I was a kid, my Dad stopped at a ‘weak’ bridge. My brothers, sisters, Mom and I walked across the bridge first and then he drove the car over.”

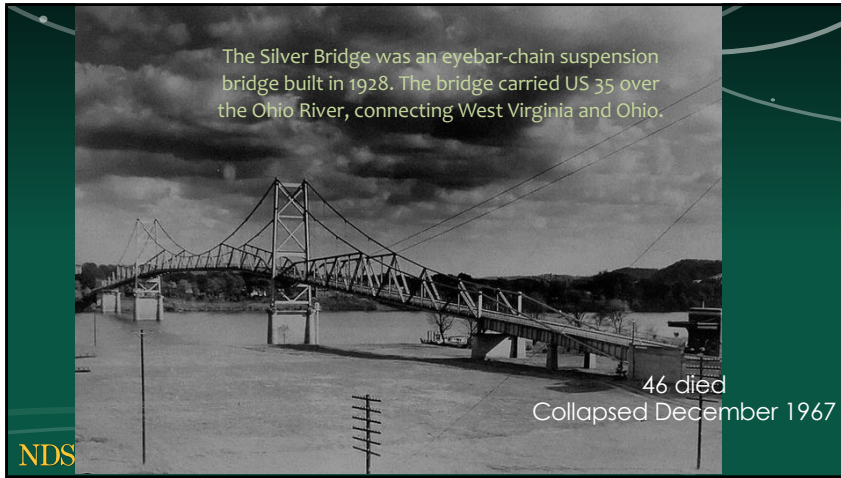
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## What is a Bridge?

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### National Bridge Inspection Program

- Why?
  - 1967 – Silver Bridge collapse (fracture of an eyebar at a pin connection)
  - 1968 – National bridge inspection (NBI) program initiated (requiring regular and periodic inspections)
  - 1971 – National bridge inspection standards (NBIS) adopted (prescribe how, with what frequency, and by whom bridge inspections must be completed)
  - 1987 – Schoharie Creek collapse (scour)
  - 2007 – Minnesota I-35W collapse (undersized gusset plate design)

1985 – Adopted 20'+ major structures and dropped minor structure inspections

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### Bridge Definition

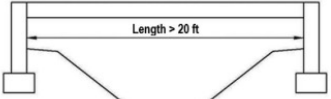


Figure 1: Example of NBI Bridge Length Bridge

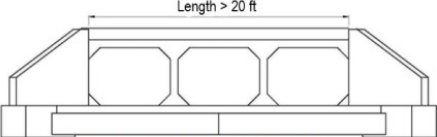


Figure 2: Example of NBI Bridge Length Box Culvert

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### Bridge Definition

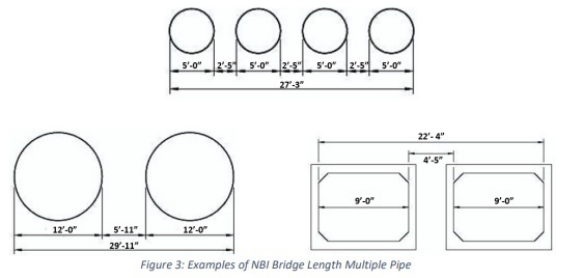
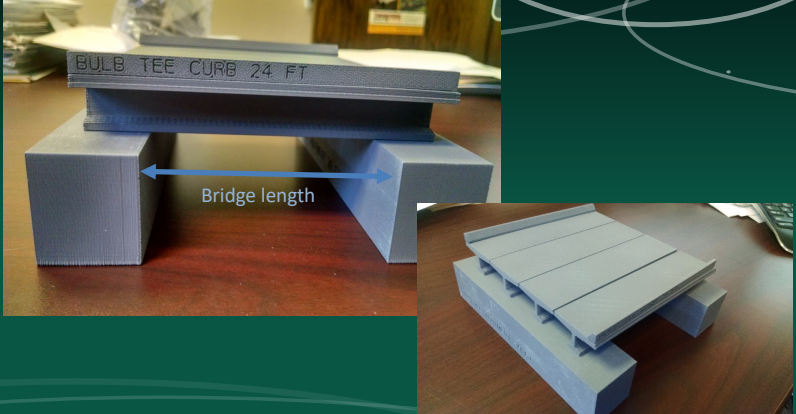


Figure 3: Examples of NBI Bridge Length Multiple Pipe

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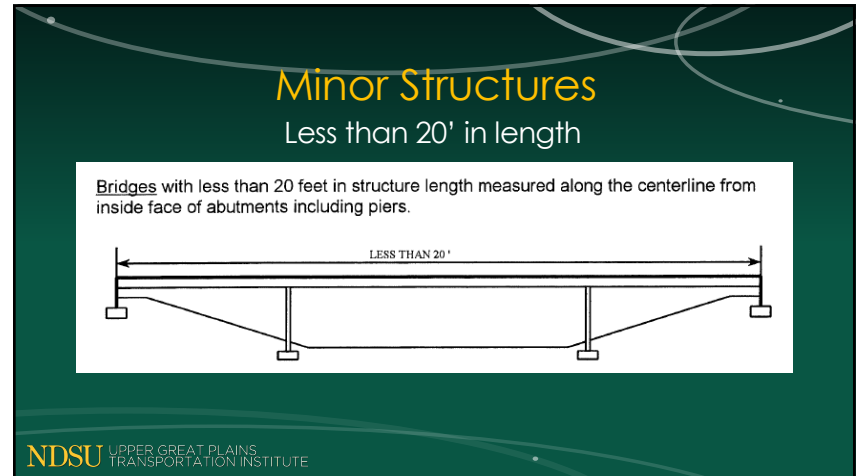
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## Minor Structures

Less than 20' in length

**All Reinforced Concrete Box Culverts** having less than 20 feet of length measured parallel to centerline of roadway from between inside faces of exterior walls.

LESS THAN 20'  
INSIDE FACES OF EXTERIOR WALLS

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## Minor Structures

Less than 20' in length

2.4' | 2.3' | 19.7' | 7' | 31' | 12' | 7' | 12' | 21' | 5' | 8' | 8'

MINOR TWO STRUCTURES      MINOR TWO STRUCTURES

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## Bridge Parts

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## Bridge Components and Terms

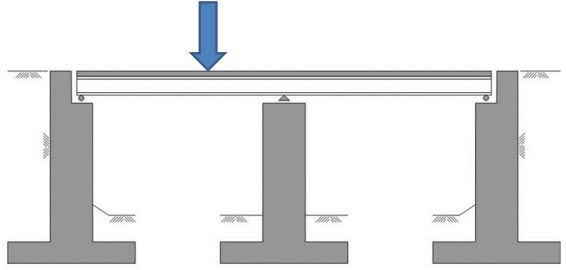
- Three Major Bridge Components
  - Deck
  - Superstructure
  - Substructure

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**Deck**

- Portion of the bridge that you drive on



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**Wooden Deck**

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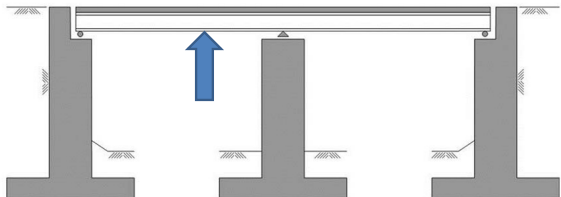
**Beams as a deck**

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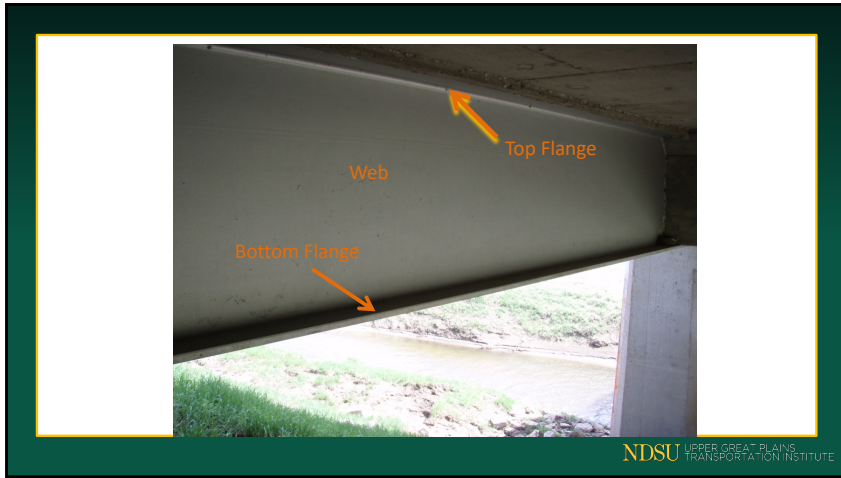
**Superstructure**

- Portion of the bridge that lies directly below and supports the deck
  - Beams, girders, truss, arch



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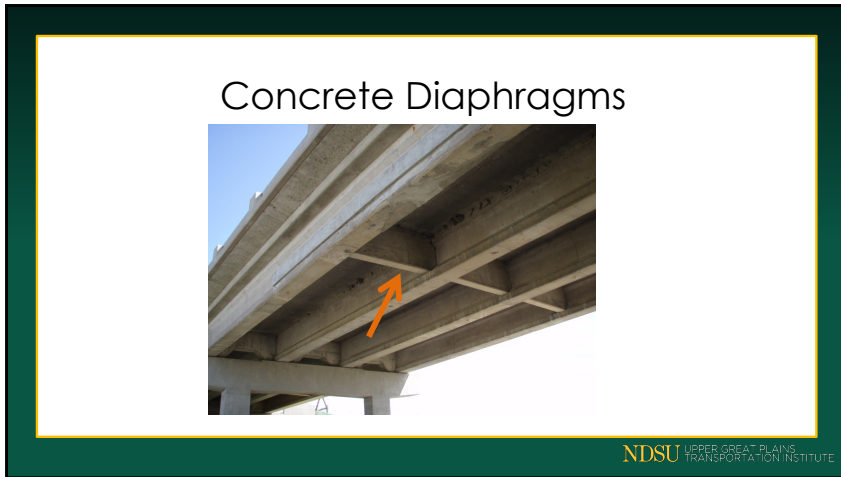
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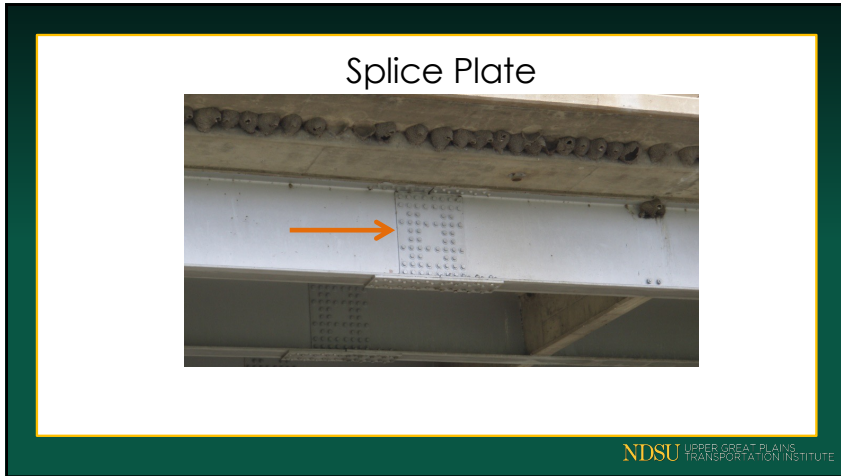
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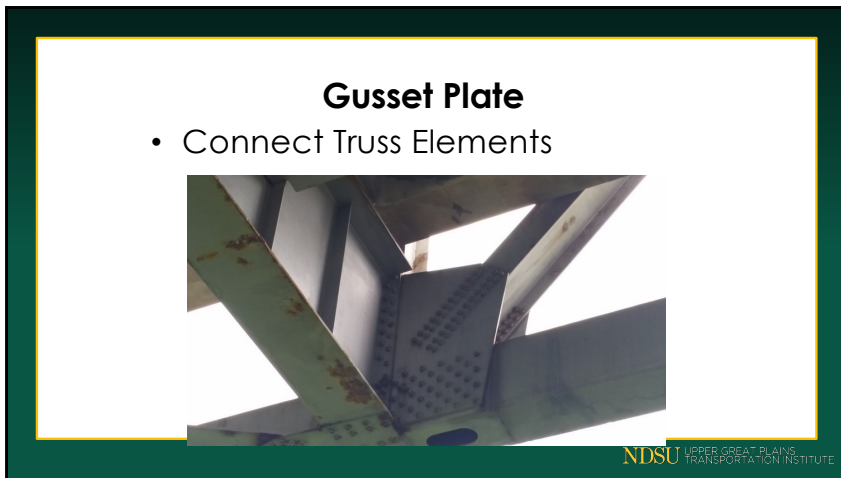
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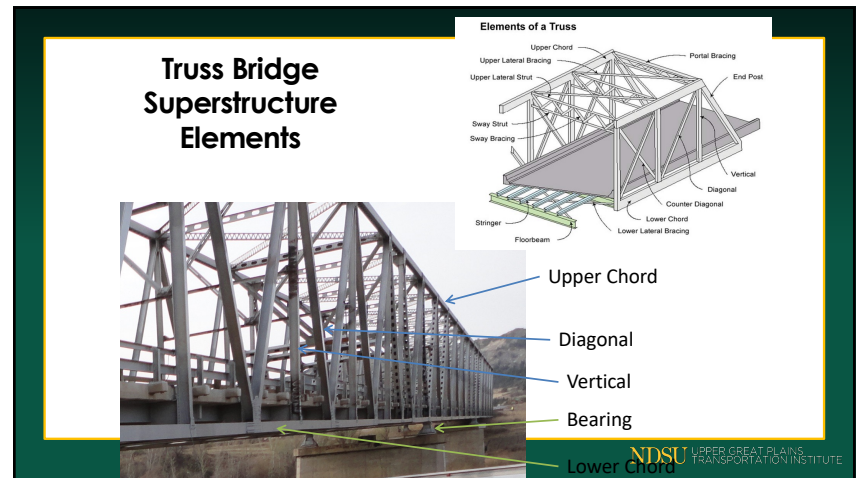
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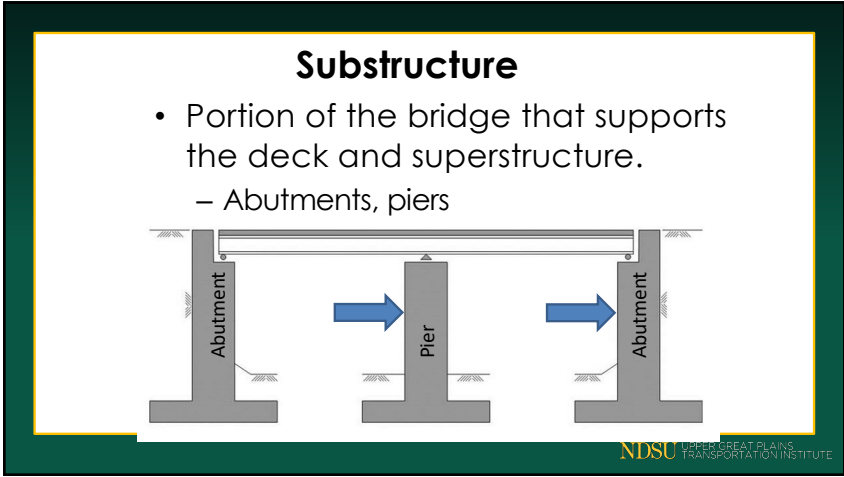


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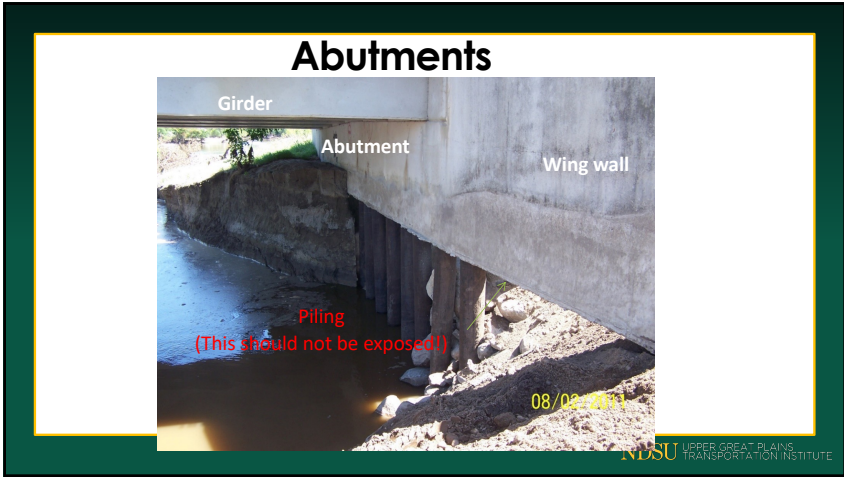




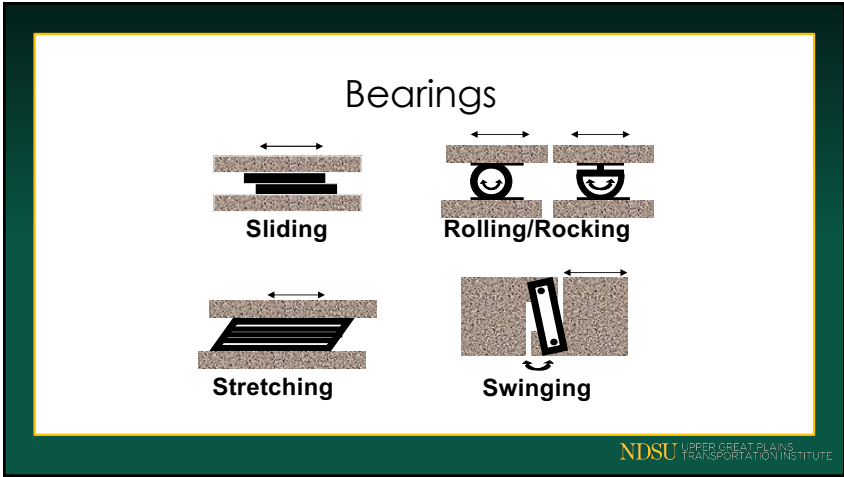
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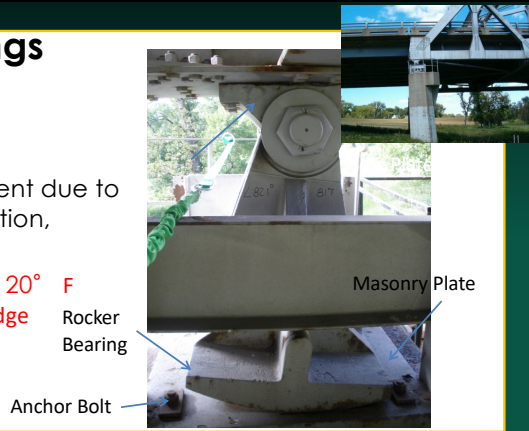
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## Bearings

- Transfer loads from Superstructure to Substructure
- Provide for movement due to expansion, contraction, rotation
- $\frac{3}{4}$ " expansion with 120° F temp change - 100' bridge



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## Wood Pile Foundations



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## Steel Pile Foundation



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## Ice Nose

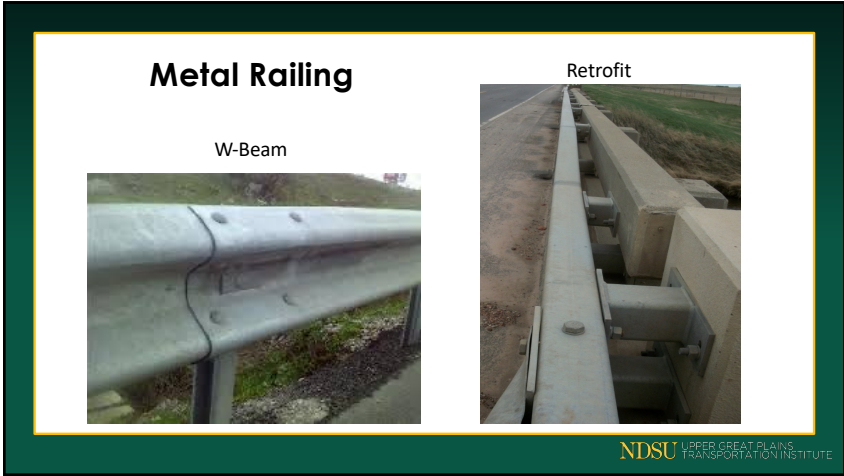


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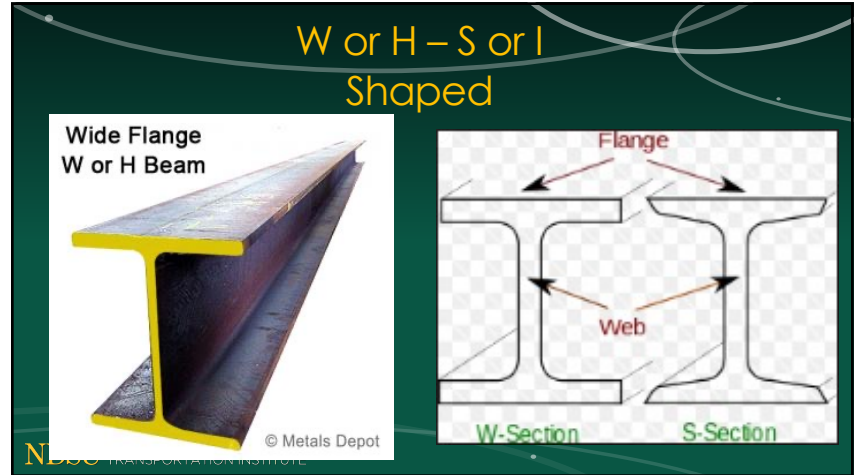
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# Bridge Loadings

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# Unit Weights

Water = 62.4 #/cubic foot

Gasoline = 42  
Ice = 56

Wood = 25 - 50  
Gravel = 120  
Asphalt/Concrete = 150  
Aluminum = 168  
Steel = 490

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# Dead Load

Gravel  
Asphalt  
Combination



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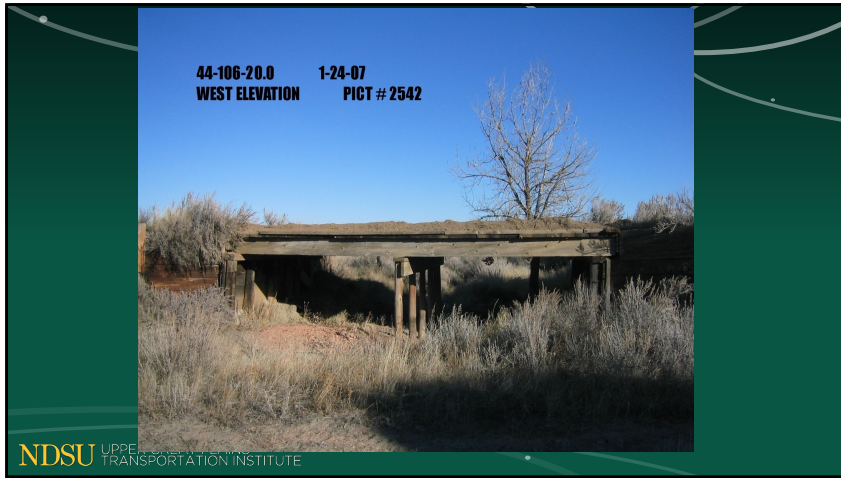
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# Overburden



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### Live Load (Inventory/Operating\*)

**FIGURE 2: HS20 TRUCK**

\*Also Referred to as Design Level

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### Live Load (Legal Level/Posting)

#### AASHTO Legal Vehicles

#### Special Hauling Vehicles

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### Special Hauling Vehicles

Figure D6.6-7—Bridge Posting Loads for Single-Unit SEVs that Meet Federal Bridge Formula B

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## Bridge Inspections

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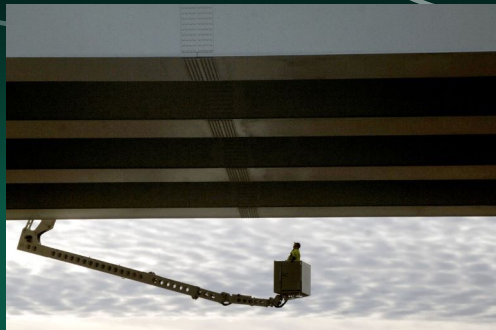
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## Bridge Inspections

- Federally mandated
- Includes all bridges (>20' span)
- Normal frequency – 24 months
- Special frequency – 12 months or other
- Special frequency – 48 months (box culverts – but not all of them)

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Jake Mertz, with the North Dakota Department of Transportation, maneuvers an aerial lift to reach under the Liberty Memorial Bridge during a routine structure inspection in Bismarck on Monday. The bridge, dedicated on Veteran's Day in 2008, replaced the original 1920 bridge spanning the Missouri River between Bismarck and Mandan. The inspectors look for cracks in the piers, corrosion and light bulb replacement. Burleigh County has 2,985 structures receiving inspections from the department on a two-year rotation. **November 28, 2017 Bismarck Tribune**

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## Underwater Inspections

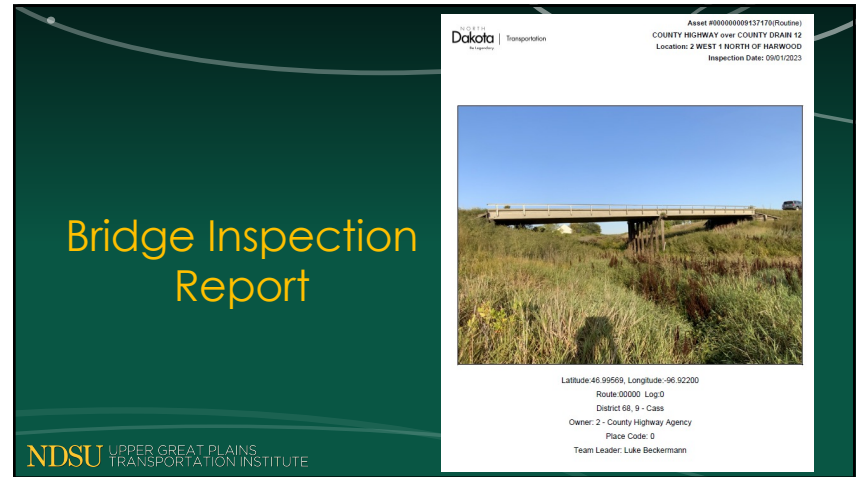


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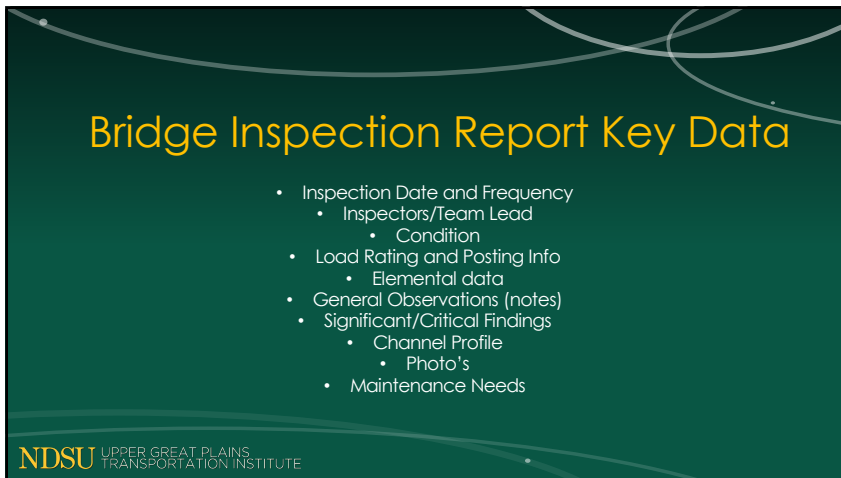
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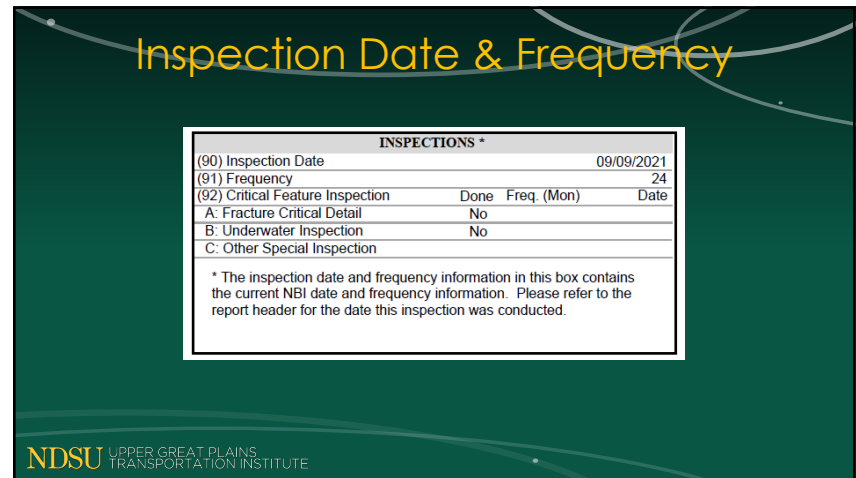
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INSPECTIONS *			
(90) Inspection Date			09/09/2021
(91) Frequency			24
(92) Critical Feature Inspection	Done	Freq. (Mon)	Date
A: Fracture Critical Detail	No		
B: Underwater Inspection	No		
C: Other Special Inspection			

\* The inspection date and frequency information in this box contains the current NBI date and frequency information. Please refer to the report header for the date this inspection was conducted.



## Team Lead and Inspector(s)

Team Leader: Carl Entzie  
Approved By: Luke Beckermann

Inspectors: KF, CE, LB, GS

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## Good – 7 to 9 Fair – 5 to 6 Poor – 0 to 4

CONDITION	
(58) Deck	7
(59) Superstructure	6
(60) Substructure	5
(61) Channel & Channel Protection	6
(62) Culverts	N

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## Load Rating & Posting

LOAD RATING AND POSTING	
(31) Design Load	0 - Other or Unknown
(63) Operating Rating Method	1
(64) Operating Rating	48.7
Type	1 - Load Factor(LF)
Rating	86.9
(65) Inventory Rating Method	1 - Load Factor(LF)
(66) Inventory Rating	29.1
Type	A

LOAD RATING AND POSTING		LOAD POSTING	
(31) Design Load	2 - M 13.5 / H 15	(31) Design Load	0 - Other or Unknown
(63) Operating Rating Method	1 - Load Factor (LF)	(63) Operating Rating Method	1
(64) Operating Rating	48.7	(64) Operating Rating	30.9
(65) Inventory Rating Method	1 - Load Factor(LF)	(65) Inventory Rating Method	1 - Load Factor(LF)
(66) Inventory Rating	29.1	(66) Inventory Rating	30.9
(A-33) Max Posting Tons	00	(A-33) Max Posting Tons	1 - Load Factor(LF)
(70) Bridge Posting	5 - Equal to or above legal loads	(70) Bridge Posting	18.3
(41) Structure Open/Posted/Closed	A - Open, no restriction	(41) Structure Open/Posted/Closed	4 - 00.1 - 09.9 % below
			P - Posted for load (may inclu

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## Element Rating & Data

Item or Defect	Condition States	UNITS	TOTAL	CS1	CS2	CS3	CS4
				1 Good	2 Fair	3 Poor	4 Severe
216	Timber Abutment	LF	49	23	26	0	0
1170	Split/Delamination (Timber)	LF	2	0	2	0	0
4000	Settlement	LF	24	0	24	0	0

(1170-216) 7/6/2023 - (2) splits in abutment 2 backwall  
(4000-216) 7/6/2023 - Conditions remain the same.  
7/14/21 - Abutment 2 backwall planks exhibit settlement for full length to 3" H, exposing approach roadway backfill.  
10/3/19 - Minor backwall settlement and cap rotation at east abutment.

(107) (5) girder lines.  
(1000-107) 7/6/2023 - Conditions remain the same.  
7/14/21 - Girders exhibit areas of surface corrosion for full length.  
10/3/19 - Minor girder corrosion throughout structure.  
(1900-107) 7/6/2023 - Conditions remain the same.  
7/14/21 - Girder bottom flanges exhibit minor (unable to measure from ground level) deflections throughout, 20 LF total.  
(515-107) x-bracing between beams accounted for in steel protective coating quantities (1024 SF).  
(3440-515-107) 7/6/2023 - Conditions remain the same.  
7/14/21 - Failed at areas of corrosion. Exposed primer at all other locations.  
10/3/19 - 50% Substantial & 50% limited paint effectiveness. Paint peeling to base metal Rust evident 50%.

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## General Observations & Notes

**General Observation**  
 Date: 7/6/2023  
 Time: 9:00am  
 Temperature: 58 degrees F.  
 Weather: Sunny  
 Inspectors: KF, CE, LB, GS

Structure is inventoried from South to North  
 Beams are inventoried from West to East.  
 Channel flow is considered East to West.

7/6/2023 - Asphalt wearing surface exhibits unsealed cracking.  
 Object markers in need of repair/replacement.

**Historical Remarks:**  
 7/21/2021 - Double sided object markers at the northwest and southeast corners.  
 No flow during inspection. Flow assumed east to west.  
 Northeast end termination is not connected to the post.  
 Local scour under midspan of structure.  
 Approaches are settled up to 1.5" H. Approaches have been feather paved to 3' L x full width.  
 6/21/19 - Double B&A end marker on NW corner.

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59 - Superstructure (6 - SATISFACTORY CONDITION - structural elements show some minor deterioration.)  
 6/21/2019 - Longitudinal cracking on HBP overlay with water seepage thru bottom of beams.

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60 - Substructure (5 - FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.)  
 6/21/2019 - S abut is slightly out of plumb, appears to have been constructed that way. West wings have minor scour.  
 East abutbeam corners broken out, S has corroded rebar in the wing exposed.  
 N abut is out of plumb in 2'-measured top half - 10/07 1" NE, 7/8" NW, 11/09@37D 1 5/8" NE, 1 7/16" NW, 11/11@55D 1 5/8" NE / 1-1/2" NW, 10/13@35D 1 3/4" NE, 1 3/8" NW, 10/15@51D NE 2 1/4", NW 1 5/8", 08/21 - NW 1 1/2" NE 1 3/4" @ 74 Degree

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61 - Channel/Channel Protection (6 - Bank is beginning to slump. River control devices and embankment protection

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## Significant Findings

**1.6.5 Significant Findings**  
 Significant findings are intended to identify specific defects or conditions that warrant further attention, action, or monitoring, but do not require *immediate* attention or action.

Significant findings include, but are not limited to:

1. Unanticipated movement or settlement of a substructure, approach slabs, or other bridge elements, particularly where movement may be ongoing
2. Moderate or major cracks in reinforced concrete where propagation needs to be monitored
3. Advanced decay or cracks in timber
4. Heavy rust on steel members with measurable section loss
5. Exposed rebar on structural members

A maintenance work item is required to be issued for any significant finding.

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## Critical Findings

1. Examples of critical findings for all structures:

- a. Primary structural member(s) with collision damage or deterioration seriously affecting structural capacity.
- b. Substructure units with severe scour and undermining of substructure foundation(s) causing instability. This is defined as the scour condition rating coded 2 or less
- c. Load posting is required, but not implemented (all signs not in-place or not correctly posted).
- d. A bridge coded as closed (item 41 = K) is found to be open.

4. Examples of critical findings for timber structures:

- a. Deck planks with through-hole or that are in danger of failing.
- b. Primary superstructure member with crushing/decay or multiple open cracks (splits) in high stress area.
- c. Piles and pier caps with loss of bearing capacity or soil retention due to crushing, decay, or damage.

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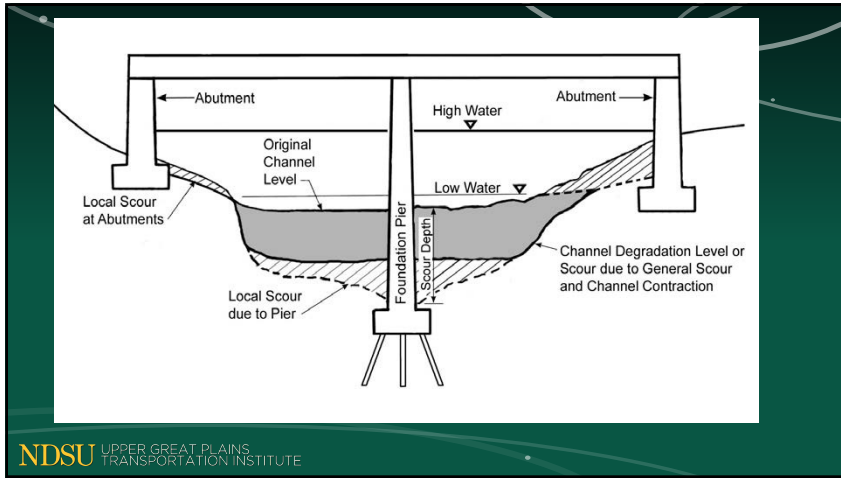
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## Critical Findings

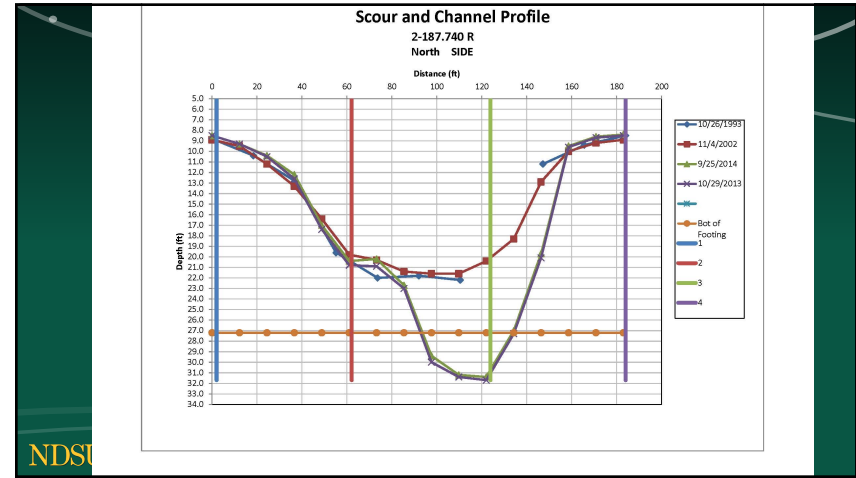


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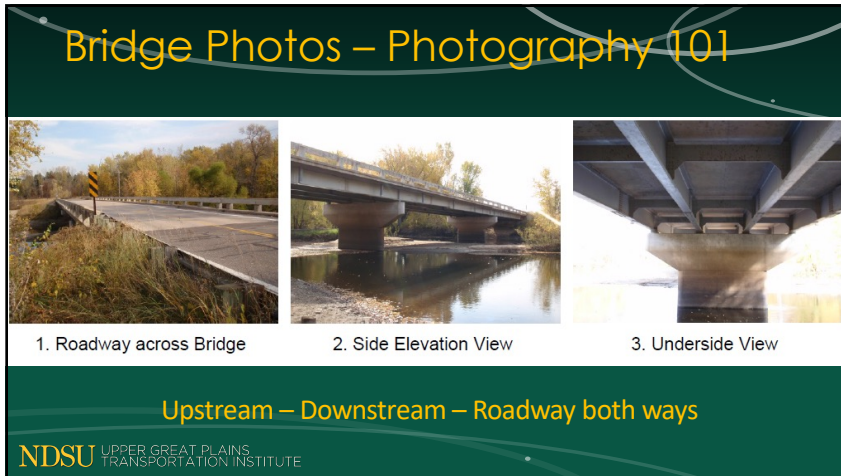
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## Maintenance


<b>Maintenance Needs</b>		<b>Maintenance Needs</b>	
Date Reported: 09/14/2021	Date Reported: 09/29/2021	Status: Unknown	
Priority: Medium	Priority: Medium	Component: Element	
Type of Work: Install / Replace Object	Type of Work: Repair Wingwall		

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<b>Deficiency Description</b>	<b>Deficiency Description</b>
Object marker only present at the north	Wingwall piles exhibit rot from 10%-50%. Northeast wingwall exhibits a pile with decay to 90%. Northwest wingwall exhibits failure of the top plank and (3) of the top backboards. Fill is beginning to spill through.
<b>Remarks</b>	<b>Remarks</b>
Install object markers at all corners.	Replace wingwall piles. Replace top plank and (3) top backboards at the northwest wingwall.



Bridge rails do not meet AASHTO st



Failed top plank and backboards at the northwest



Rotted pile at the northeast wingwall

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Caterpillar 140M3 Motor Grader typical weight is about **22 tons**

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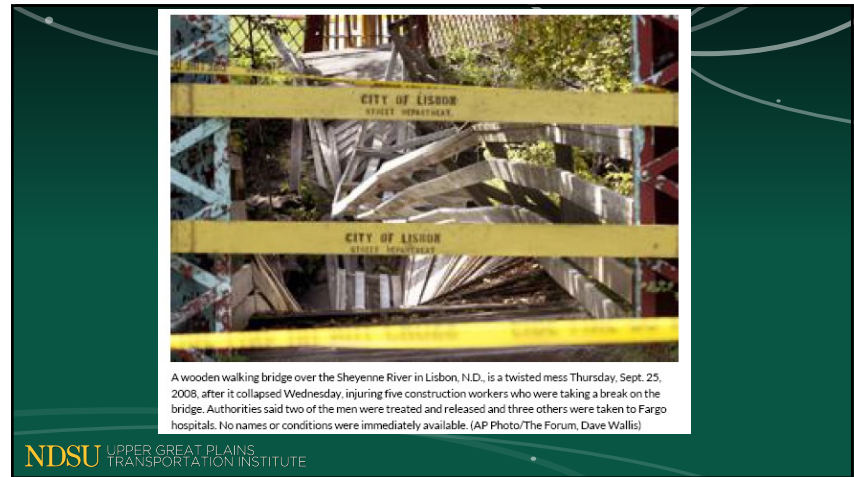
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**Bridge in rural N.D. collapses under weight of truck**  
 By Patrice Tyson, Special Today at 8:28 a.m.



FOREST RIVER, N.D. — A semi driver is lucky to be safe after a bridge caved while crossing it.

A woman who lives nearby by the crash site, Holly Beaton, says it happened around 10 a.m. Thursday, Oct. 19 near Forest River.

The truck appears to have been hauling grain when the bridge gave out, causing the cab of the truck to be caught in the air.

Beaton says the driver made it out safely, and the sheriff's office told her the truck will be stuck in the bridge for a few days while they wait for a crane to get it out.

Authorities have not yet commented.

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Questions?

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Thank you!

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