

# Fracture Critical Bridge Inspection



**Presented by MN/DOT Bridge Safety Inspections**

MN/DOT's fracture critical bridge inspection team performs in-depth and special inspections for State, County and City owned bridges throughout Minnesota. All inspectors are certified for bridge inspection in accordance with Federal Highway Administration regulations. In addition, there are 3 inspectors nationally certified in nondestructive testing.

## Definitions

**Fracture Critical Member:** A steel member in tension, whose failure would probably cause a portion or the entire bridge to collapse.

**Fracture Critical Bridge:** A bridge that contains a fracture critical member. Usually a bridge with only 2 main load paths.



## Structurally Deficient:

The classification "Structurally Deficient" is used to determine eligibility for federal bridge replacement and rehabilitation funding. Bridges are classified as "structurally deficient" if they have a general condition rating of poor for the deck, superstructure or substructure (piers and abutments). Examples of poor condition include corrosion that has caused significant section loss of steel support members, movement of substructures, or advanced cracking and deterioration in concrete bridge decks. For bridge owners, the classification structurally deficient is a reminder that the bridge may need further analysis that may result in load posting, maintenance, rehabilitation, replacement or closure. The fact that a bridge is structurally deficient *does not* imply that it is unsafe. A structurally deficient bridge typically needs maintenance and repair and eventual rehabilitation or replacement to address deficiencies. To remain open to traffic, structurally deficient bridges are often posted with reduced weight limits that restrict the gross weight of vehicles using the bridges. If unsafe conditions are identified during a physical inspection, the structure will be closed.

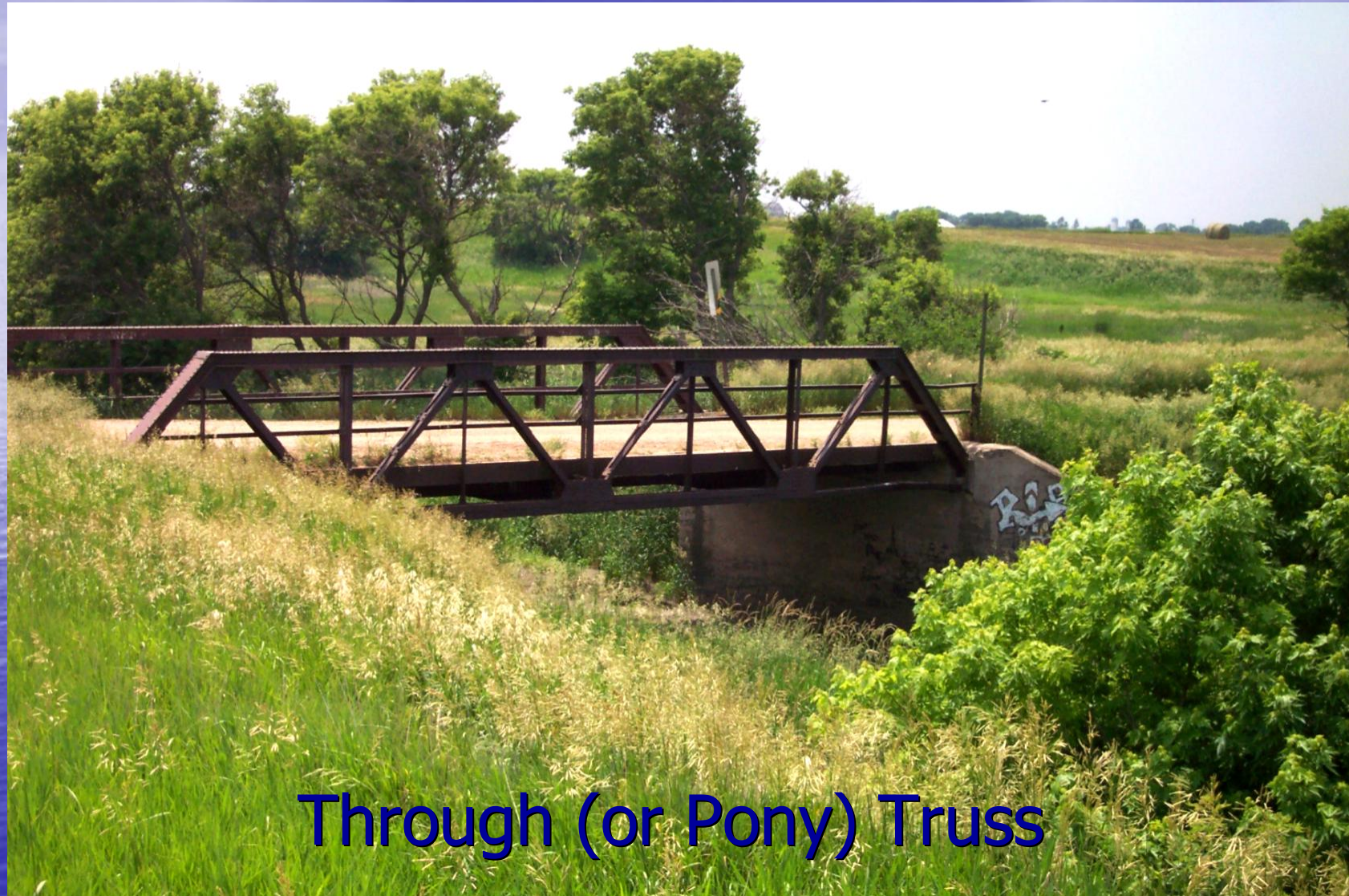


# Examples of Fracture Critical Bridges

## High Truss







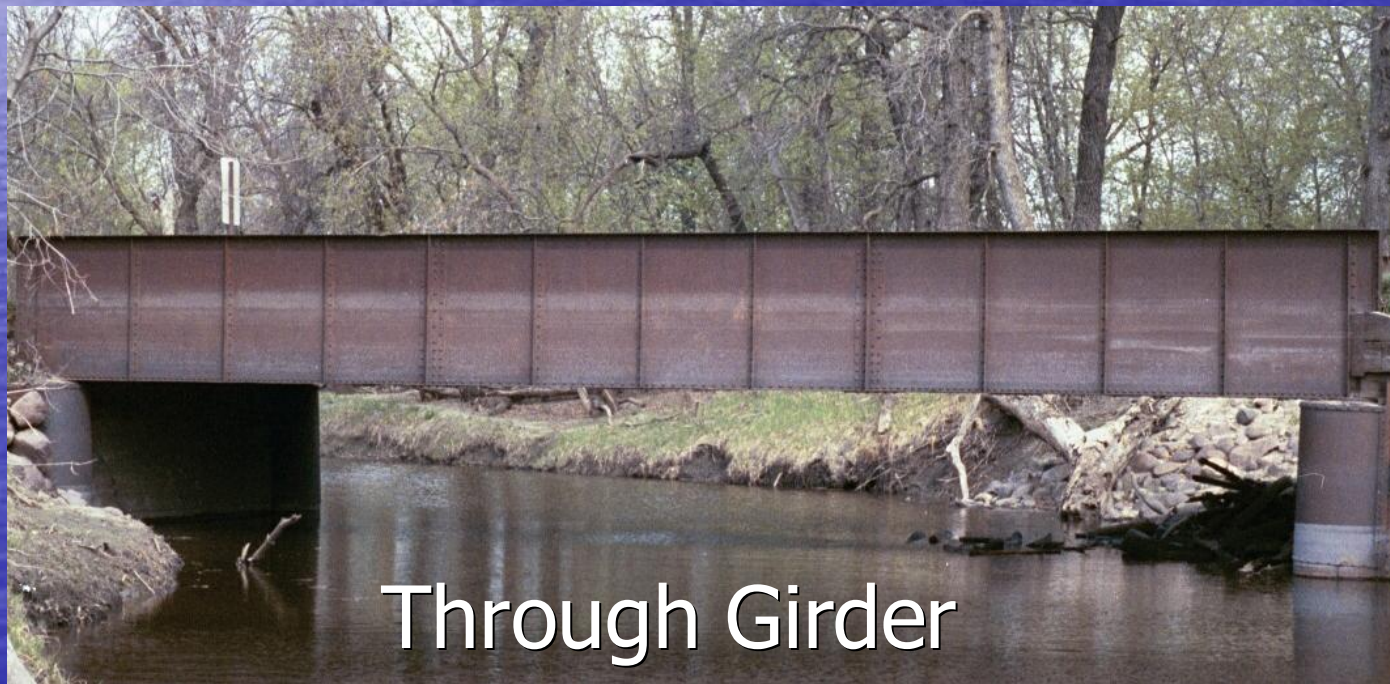
Through (or Pony) Truss





Deck Truss





Through Girder



# Arch Bridge

Not Technically Fracture Critical  
Main Members are in Compression



## Tied Arch



Bottom Chord is in Tension, Like a Bow String

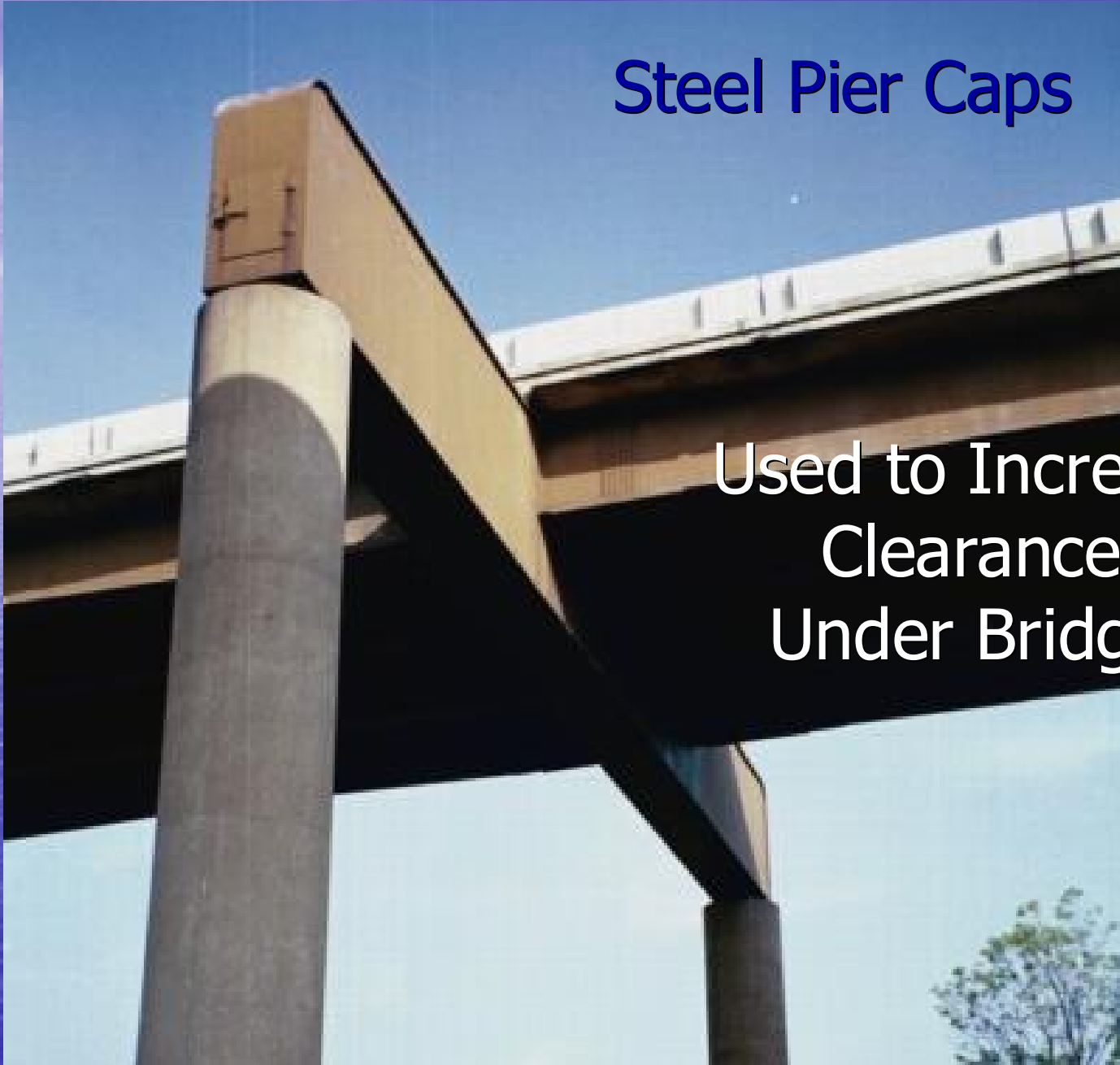




**Two Girder Bridges**

## Steel Pier Caps

Used to Increase  
Clearance  
Under Bridge





# A Brief History



In December of 1967, the Silver Bridge in Point Pleasant, West Virginia collapsed.

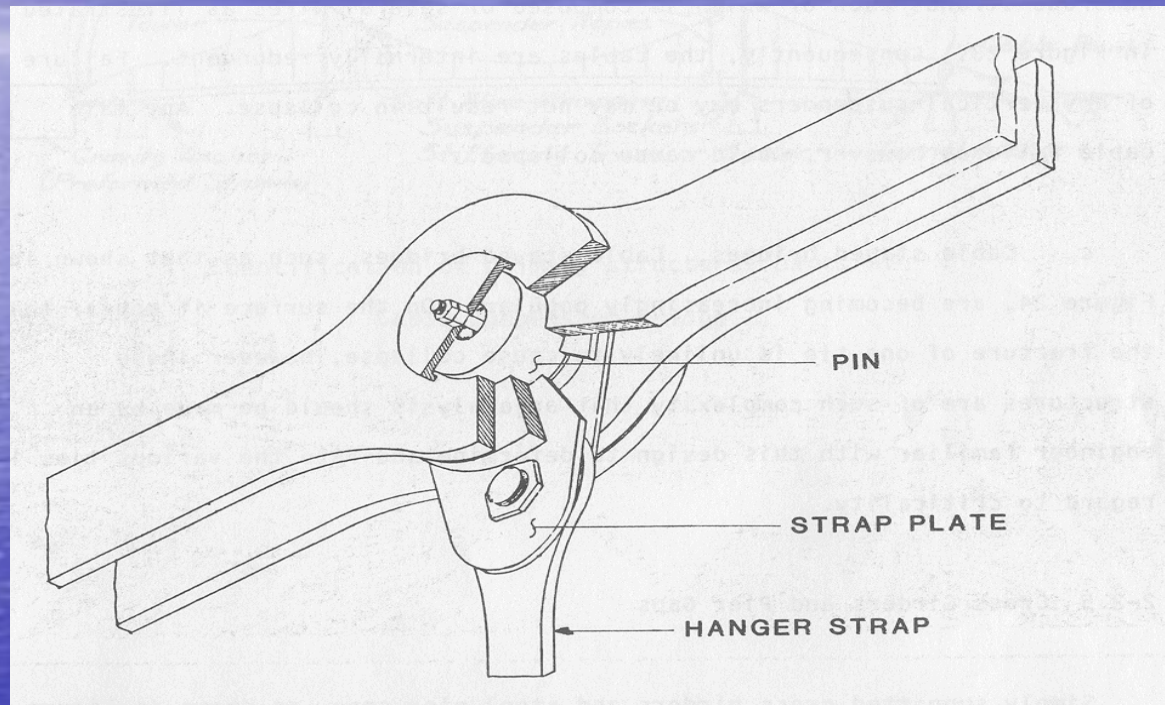
# 1967 Silver Bridge Collapse



49 motorists were  
killed.



The Silver Bridge had a pin and eyebar suspension chain instead of the conventional cable. When fatigue caused one of the eyebars to fail, the entire bridge collapsed.



Because of this failure, the 1968 Federal-Aid Highway Act required the establishment of National Standards for the Inspection of Bridges (NBIS) on the Federal-Aid Highway system.



# 1983 Collapse of the Mianus River Bridge (Greenwich, Connecticut)





The Mianus Bridge was constructed in the 1950's, and consisted of two adjacent fracture critical 2-girder steel structures with suspended spans connected by "pin-and-hanger" assemblies at each corner.

The hanger plates were 6-1/2 ft. long and 1-1/2" thick.

The plates were connected to the girder webs with 7" diameter pins.

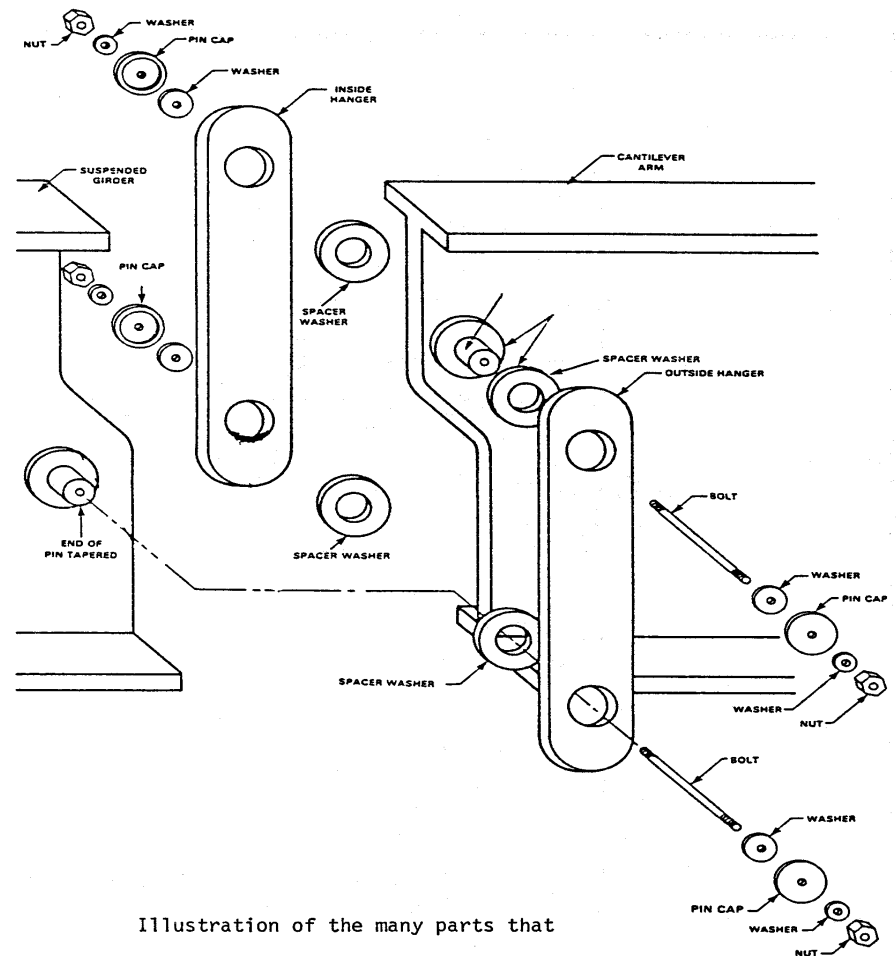


Illustration of the many parts that make up a pin and hanger assembly

The bridge failed when expanding rust (pack rust) forced the inner hanger plate to separate from the lower pin, shifting the entire load to the exterior plate and causing the upper pin to shear.

The Federal Highway Administration now requires that all bridges with pin and hanger connections be identified and designated for frequent in-depth inspections.



All bridges in Minnesota are inspected on a one or two year cycle (depending on age or condition), but bridges designated as “fracture critical” also receive an in-depth inspection every two years. “In-depth” inspection means every fracture critical member must be inspected within an arm’s reach of the member.

In addition, non-destructive testing is performed on special features (such as pin and hanger connections) during these inspections.

In 1998 the MN/DOT Bridge Office began a state-wide program for inspection of Fracture Critical Structures and Members for State, County and city owned bridges. Prior to that, inspection was the owners responsibility. The program was centralized to bring consistency and expertise to the inspection program. The Fracture Critical Inspection Team also performs special inspections on damage caused by bridge hits and flood debris, as well as inspections of poles and other bridge and highway related structures. As of now, there are about 300 bridges in Minnesota that are designated as Fracture Critical.



# How Do We Perform In-Depth Inspections?





Under Bridge Inspection Vehicles  
(Snoopers)



## 30' Snooper on a Small Rural Bridge



17 ton GVW makes 30' snooper ideal for small bridges with load postings





# 50' Snooper



# 75' Snooper on High Bridge in St. Paul





# Inspection of 35W Bridge





## 50' Snooper in Winona



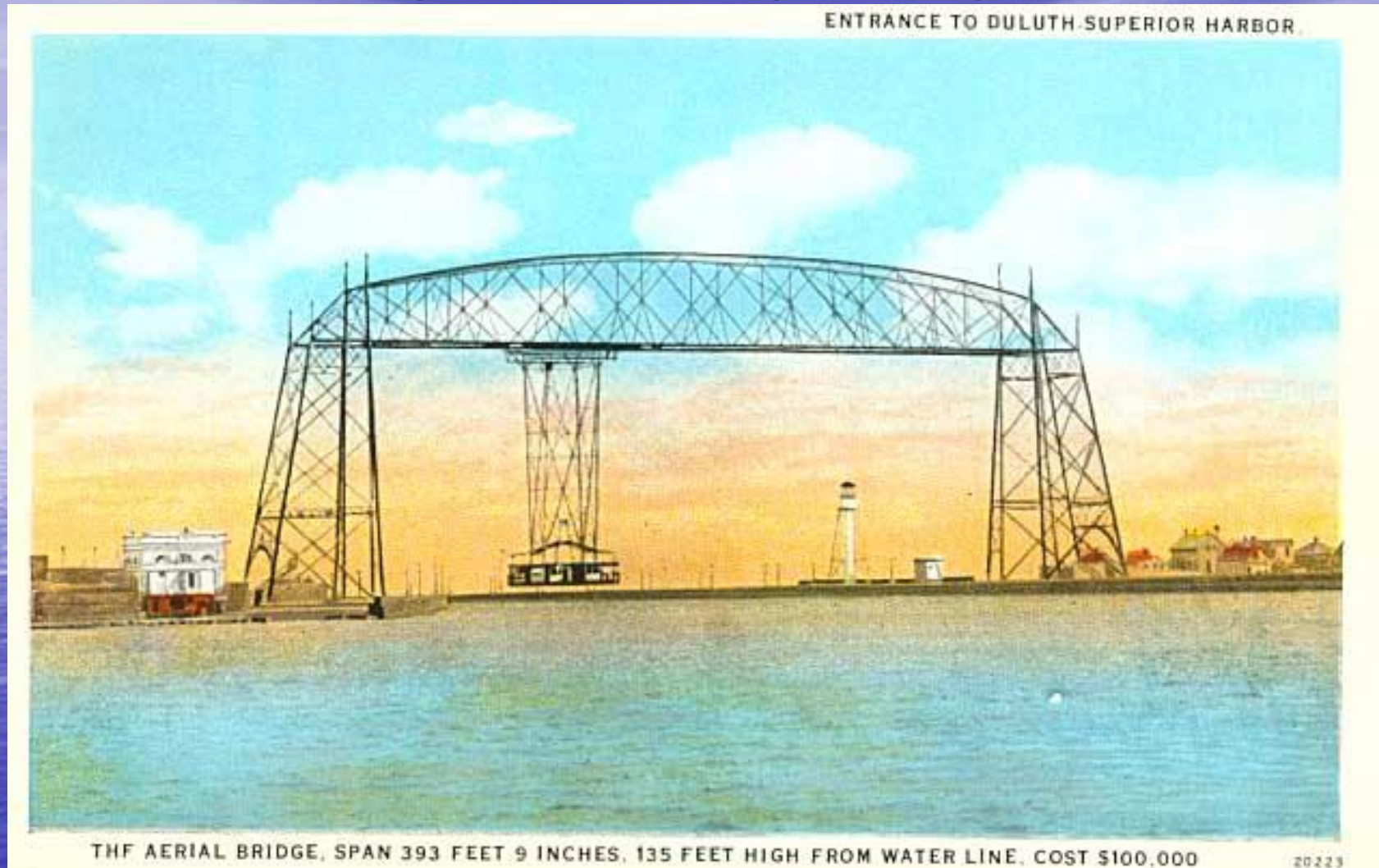


## 50' Snooper on Aerial Lift Bridge in Duluth





# Original Lift Bridge Design





# Blatnik Bridge in Duluth



## 30' Aerial Lift Van





# Boat Inspection





# Ladders





# Hanging Scaffold



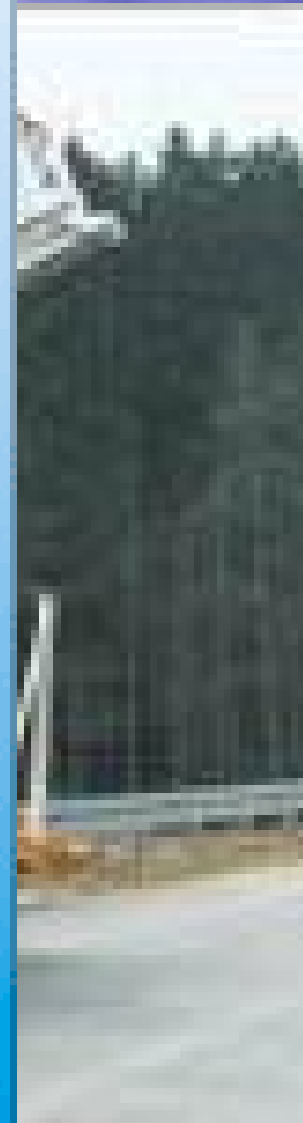
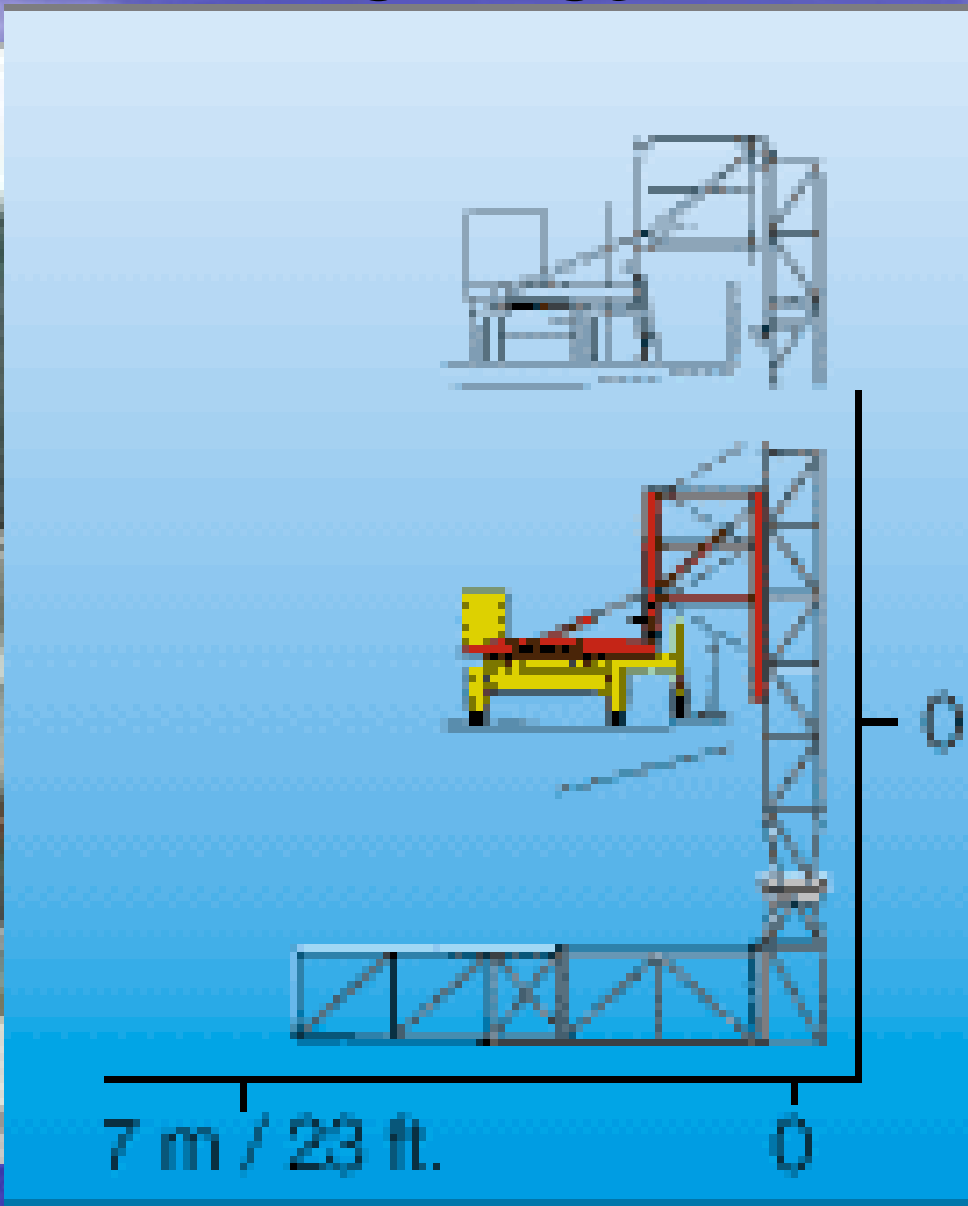


# Winter Inspection





# Wish List



# What Do We Find?

Cracks

Rust

Section Loss

Impact Damage

Scour and Undermining



# Cracks







# Bridge Closed!

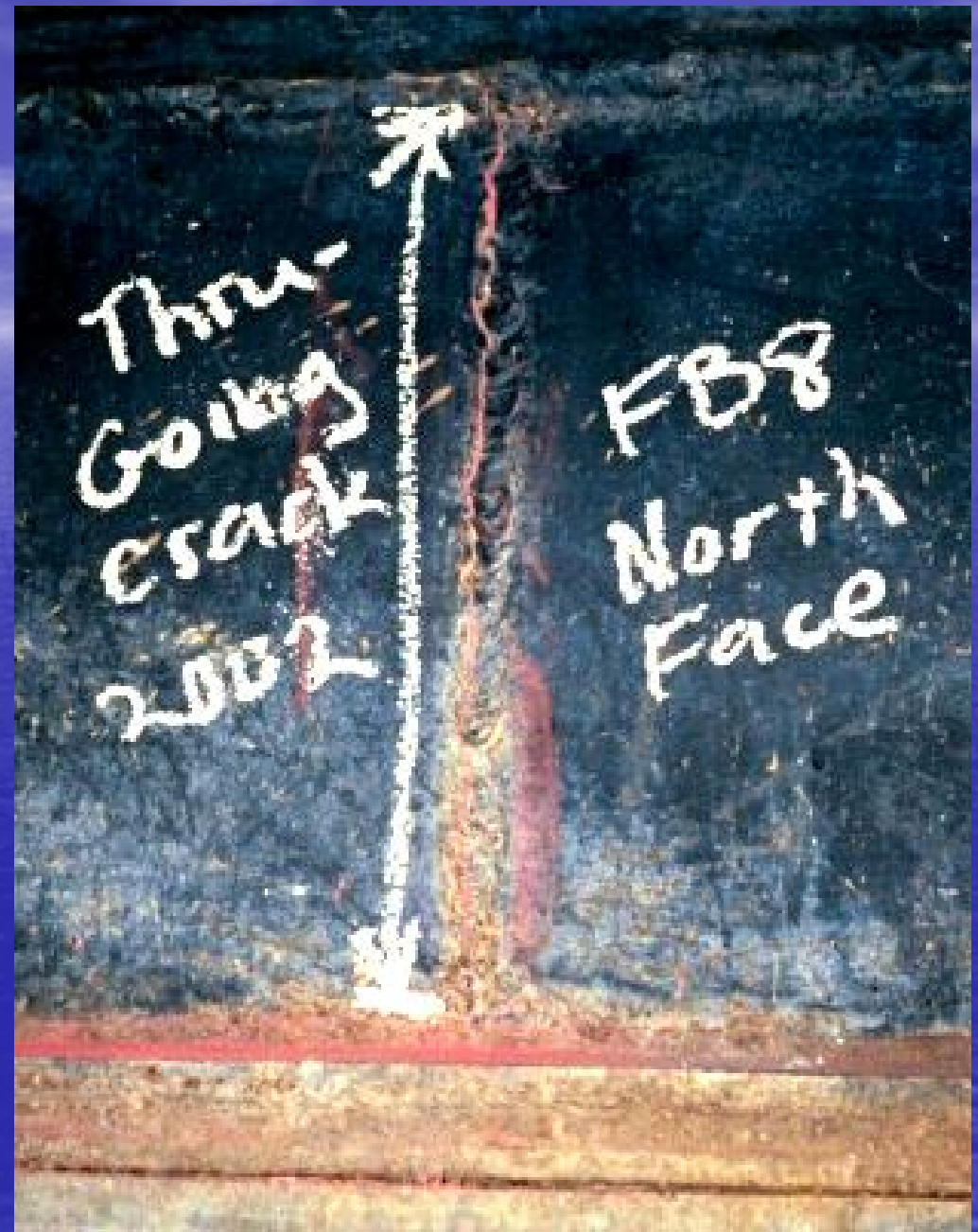
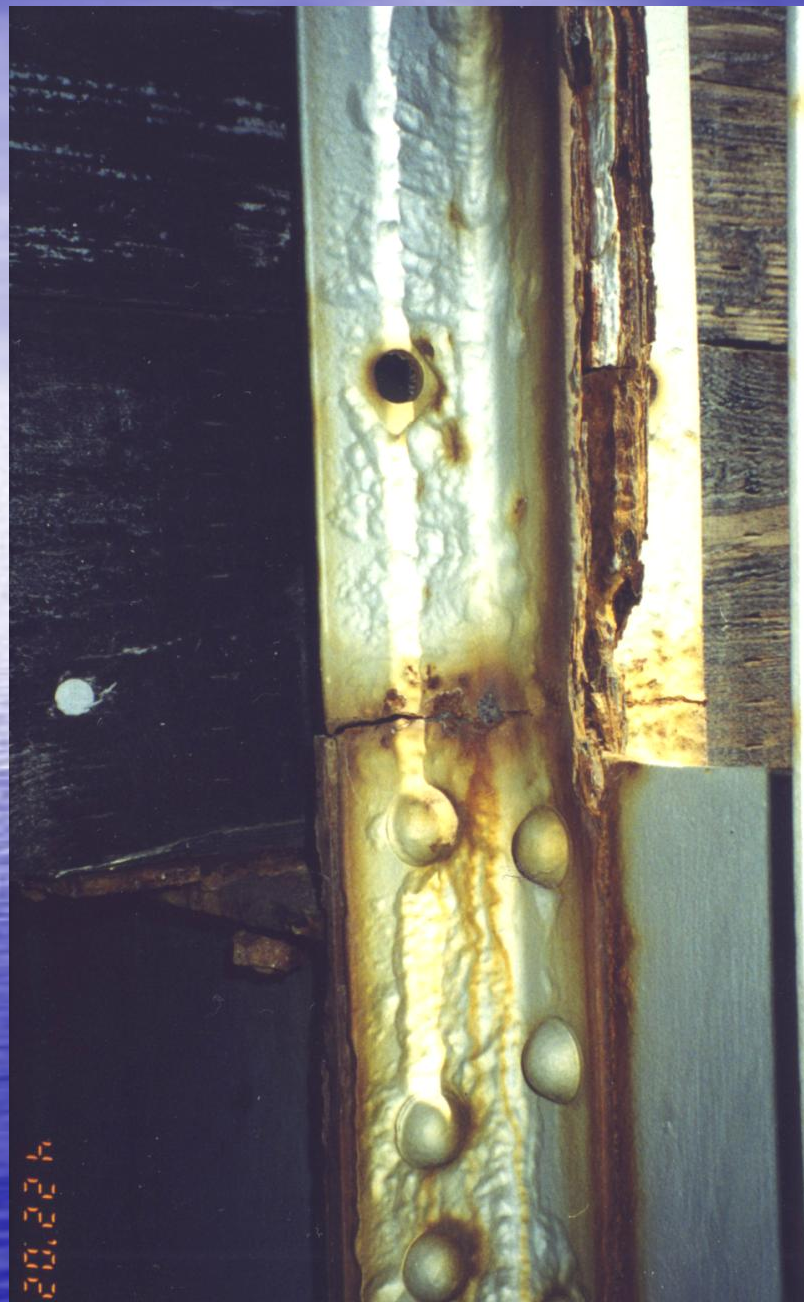




# Repair









# Crack in Lower Chord Member



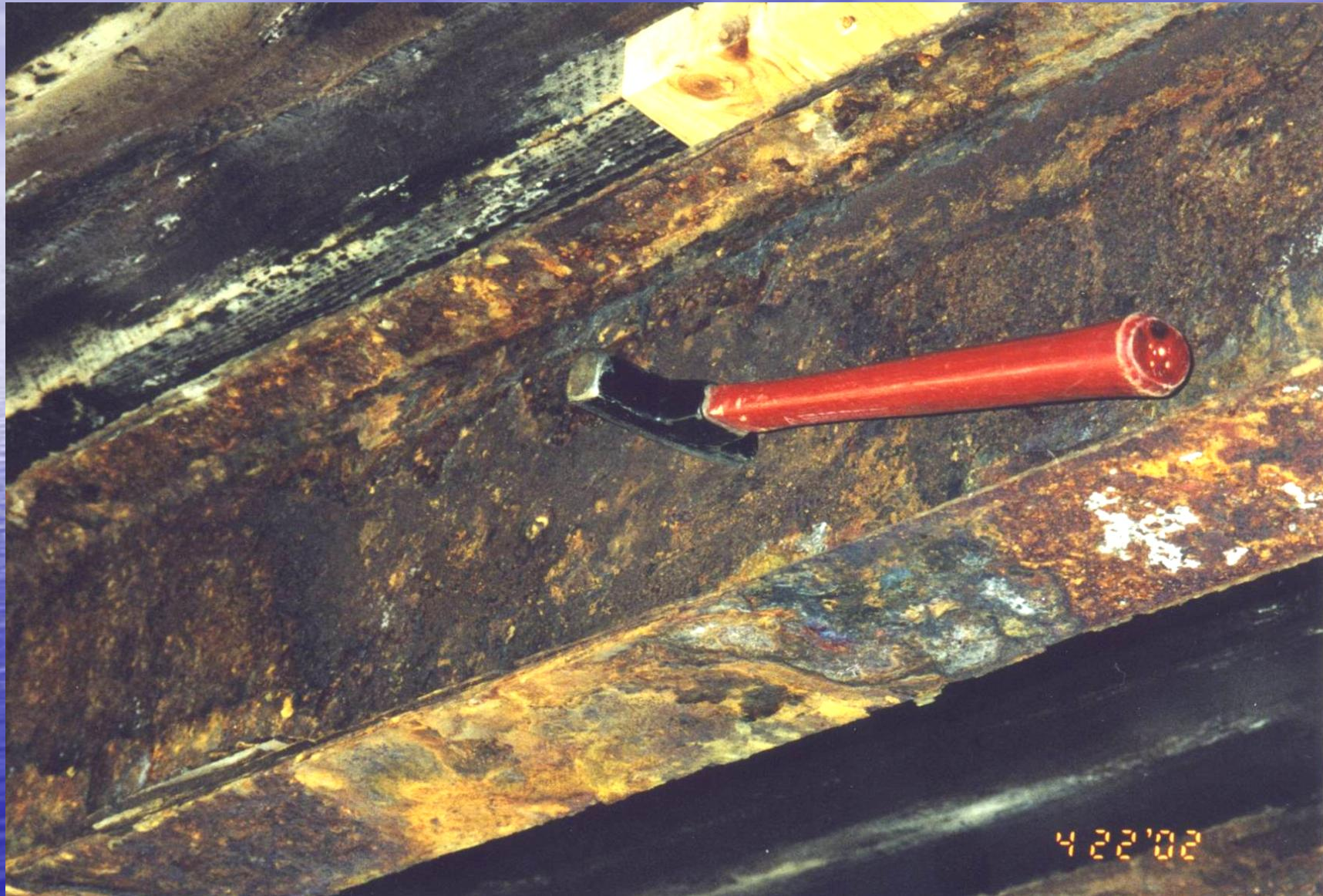


# Rust, Corrosion and Section Loss





Not a good sign!





# Corrosion and Section Loss



# Section Loss





# More Section Loss







Don't worry,  
this bridge  
is closed



# Debris on Bottom Chord





# Hammer Loosens Rust





# Removing Loose Rust



7/28/2005 11:42am



# Final Result: 30% Loss of Section





# Corrosion on Interior of Pole Causes Failure





# Pack Rust



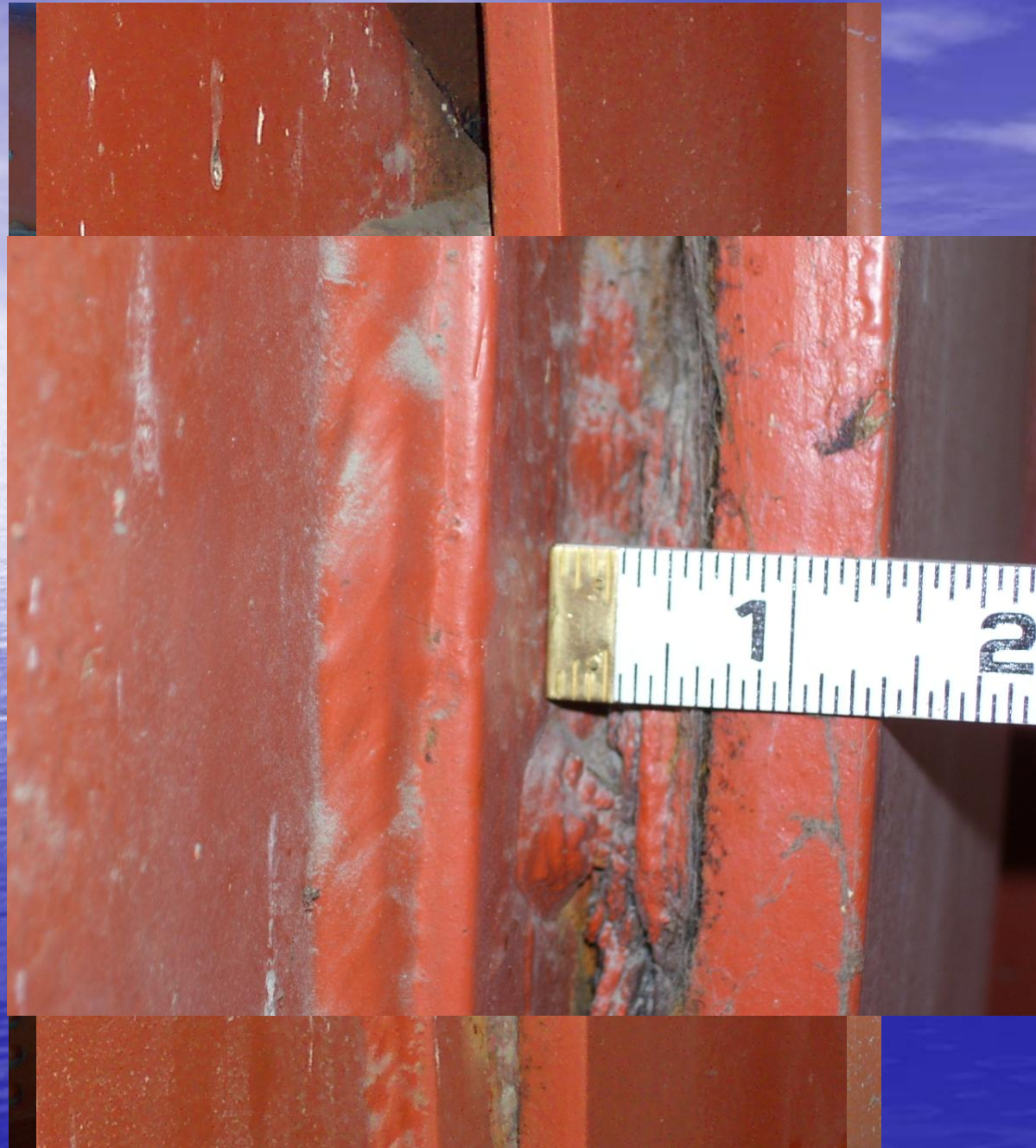
Scalloping



# More Pack Rust







Pack rust  
causing  
distortion  
of hanger  
plate



# Impact Damage



Put tank on truck first, then measure height!

# Typical Damage from Bridge Hit





# More High Load Damage



# No Longer a “Double Decker”





# Stop the Train!



1 2:35 PM

# Not Just Bridges





# Iowa Interstate





# Two More Collisions



Minnesota



# Wisconsin





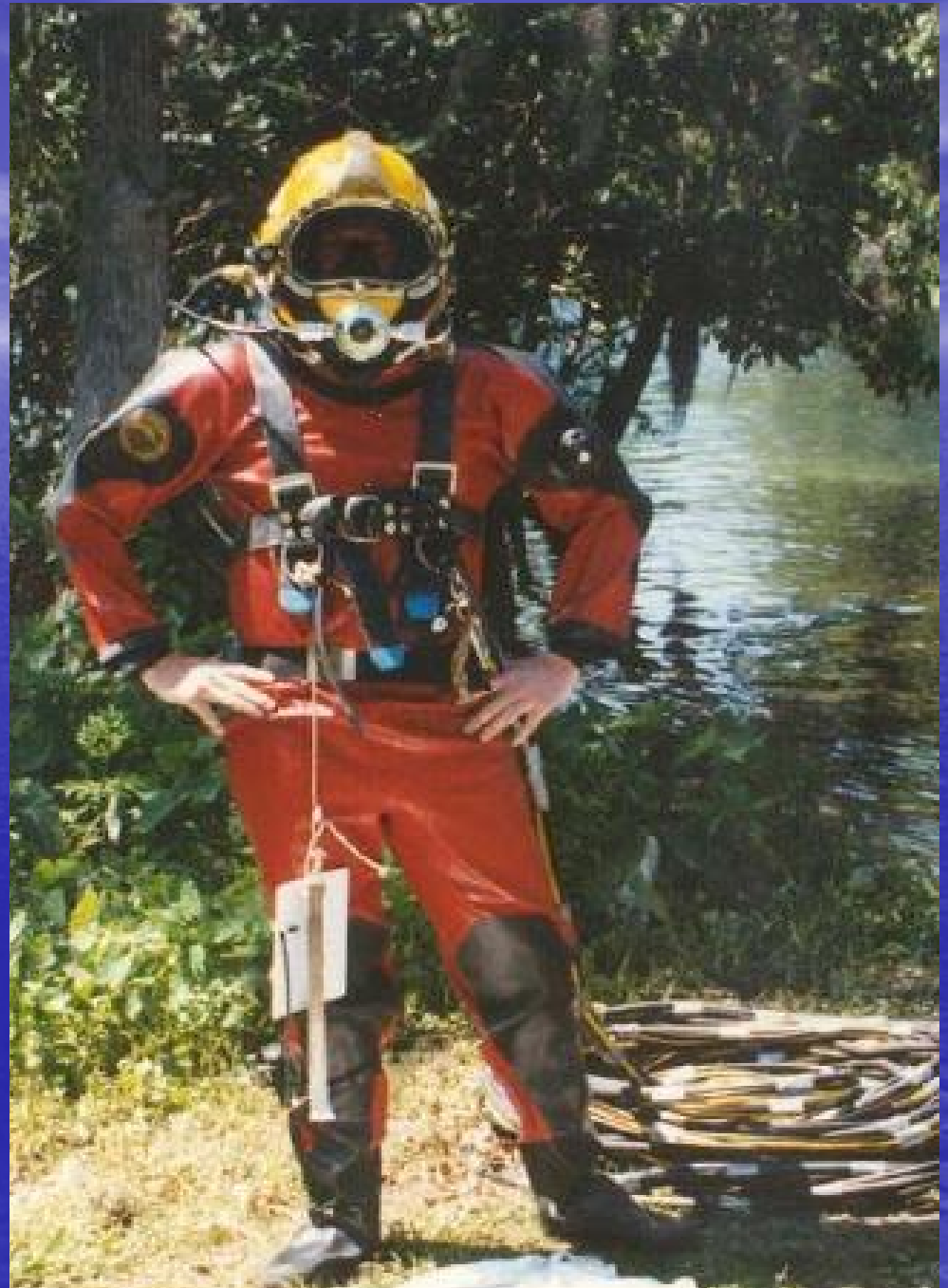
# Scour



In April of 1987 The Schoharie Creek Bridge on I-90 in New York collapsed. Undermining of piers 2 and 3 caused 3 spans to collapse, killing 10 motorists.



Due to that failure,  
the Federal  
Government now  
requires bridges that  
are determined to be  
“scour critical” have  
an underwater  
inspection  
performed every 5  
years (Minnesota  
performs  
theirs on a 4 year  
cycle)



Shallow streams can be probed by wading,  
deeper water requires professional divers





# Scour can cause piers to tip



# Typical Undermining





# Bridge failure in northern Minnesota



# Bearings





Other things we look at:



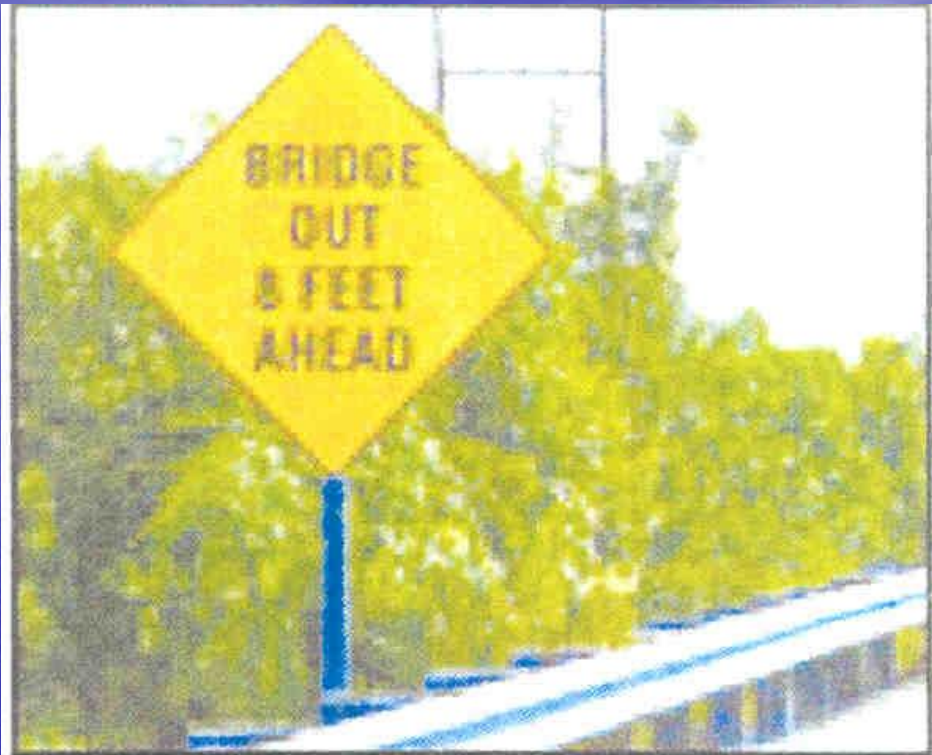


# Substructure Movement





# Proper Signage



**Dept. Of  
Transportation  
Discontinues 'Bridge  
Out 8 Feet Ahead'  
Sign**



# “Field Engineering”

Note wire  
used in  
place of  
missing  
nut



We've actually found this  
more than once!

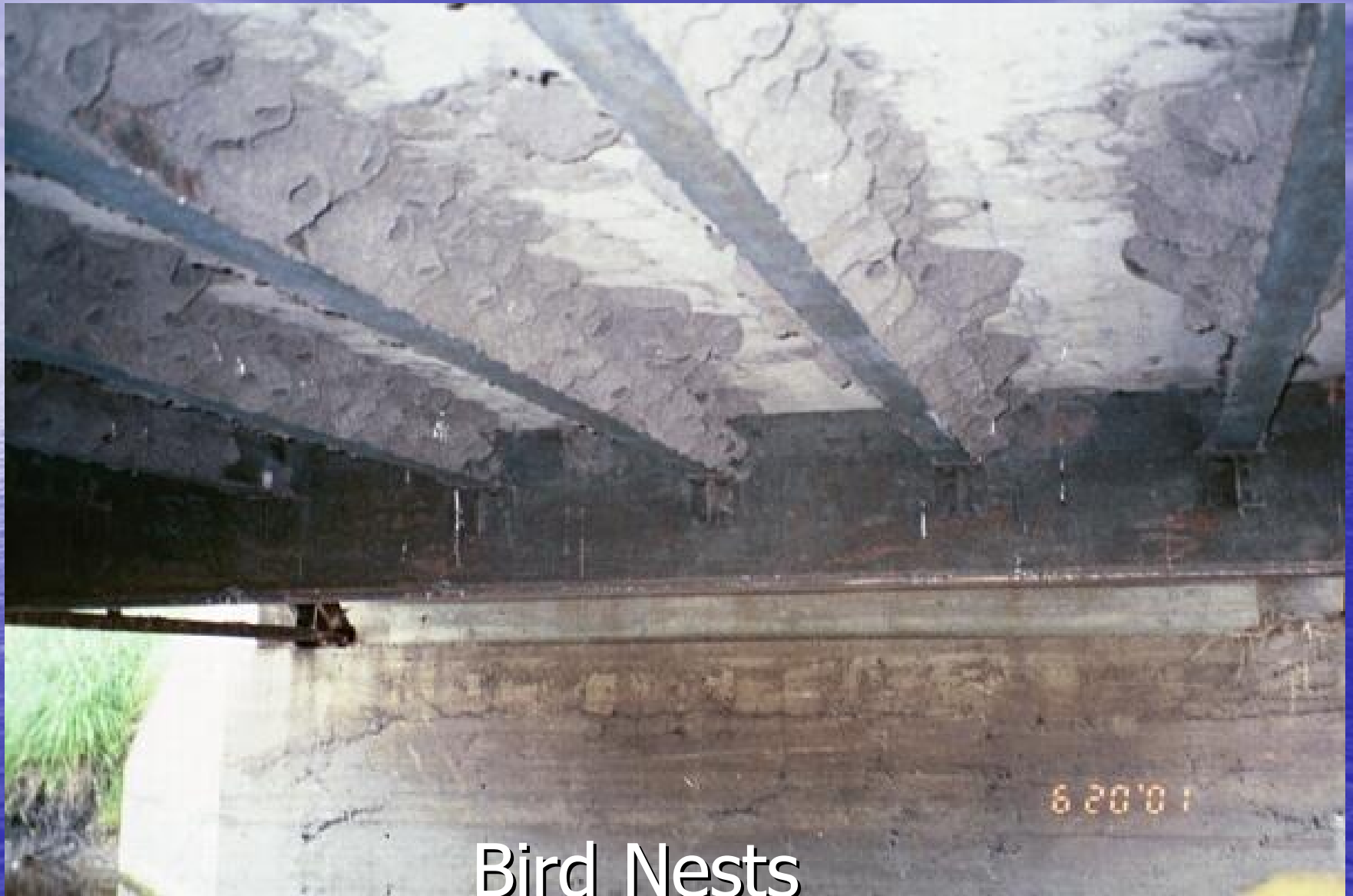


# Debris Hanging from Bridge









## Bird Nests

**Birds are protected and can't be disturbed while nesting**

# Deck Problems







MT on Bottom Flange  
UT on Top Flange  
(SCC Creeping Wave  
Methods)

05/23/2007

# Pins and Hangers





# Fatigue Prone Details









# Big Boats





# Wild Life





Are you my Mama?





# Dangerous Situations







# Moving Entire Bridge





# Metro Motorists Love Us

Sometimes they wave with all their fingers!



# Spectacular Views





The MN/DOT Fracture Critical Staff Thanks You.  
Any Questions?

