RESEARCH AND DEVELOPMENT

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Infrared Thermography and the Delamtect: A Comparison of Methods for Locating and Measuring Delaminations

Office of Research and Development
Minnesota Department of Transportation

March 1984

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Infrared Thermography and the Delamtect: A Comparison of Methods for Locating and Measuring Delaminations

INTRODUCTION

Location of delaminations, or horizontal fracture planes, in a reinforced concrete bridge deck or concrete pavement is usually done by sounding. Hollow areas struck by a heavy metal object produce a hollow sound when compared to solid areas. Sounding is typically done manually with a hammer or chain drag or mechanically with a Delamtect. The manual methods are labor-intensive and very time consuming. They are highly judgmental and require an experienced operator with a good ear. A survey with a Delamtect is considerably quicker. The device is mounted on a wheeled base and can effectively measure a two-foot wide path. Thus, six passes are required to cover a twelve-foot lane. The above methods are most effective on concrete surfaces without an asphalt overlay.

Recently another technique, infrared thermography, has become available for locating delaminations. It operates on the principle that delaminated areas heat up at a different rate from solid areas. Cracks around a delamination act as an insulator, causing the smaller delaminated mass to absorb the sun's energy faster than the larger mass of the surrounding slab. The temperature differential can be detected by an infrared camera and recorded on video tape for future analysis and mapping. Thermography is effective on both concrete surfaces and concrete overlaid with asphalt.

The Minnesota Department of Transportation (Mn/DOT) contracted with Donohue and Associates, Inc., of Sheboygan, Wisconsin, to survey five bridge decks and approximately 79 lane miles of continuously reinforced concrete pavement (CRCP) and asphalt-overlaid jointed reinforced concrete pavement in Minnesota. All of the work was in the St. Paul - Minneapolis metropolitan area except for two bridge decks, located in Moose Lake and Cloquet. Several test sections were also surveyed with Mn/DOT's Delamtect for purposes of comparing the results produced by the two techniques.

EQUIPMENT

Delamtect

The Delamtect is a device that uses an acoustic response from a tapping device to locate delaminations in bridge decks or pavements. The device is mounted on wheels and is about the size of a lawnmower. It is pushed by the operator at walking speed. The manufacturer is SIE, Inc., of Fort Worth, Texas. The Delamtect is shown in Figures 1 and 2.

The Delamtect is powered by a twelve volt automobile battery. The machine basically consists of a dual-wheel tapping device, a pair of sonic receiver wheels, an electronics unit to process signals and a two-channel chart recorder.

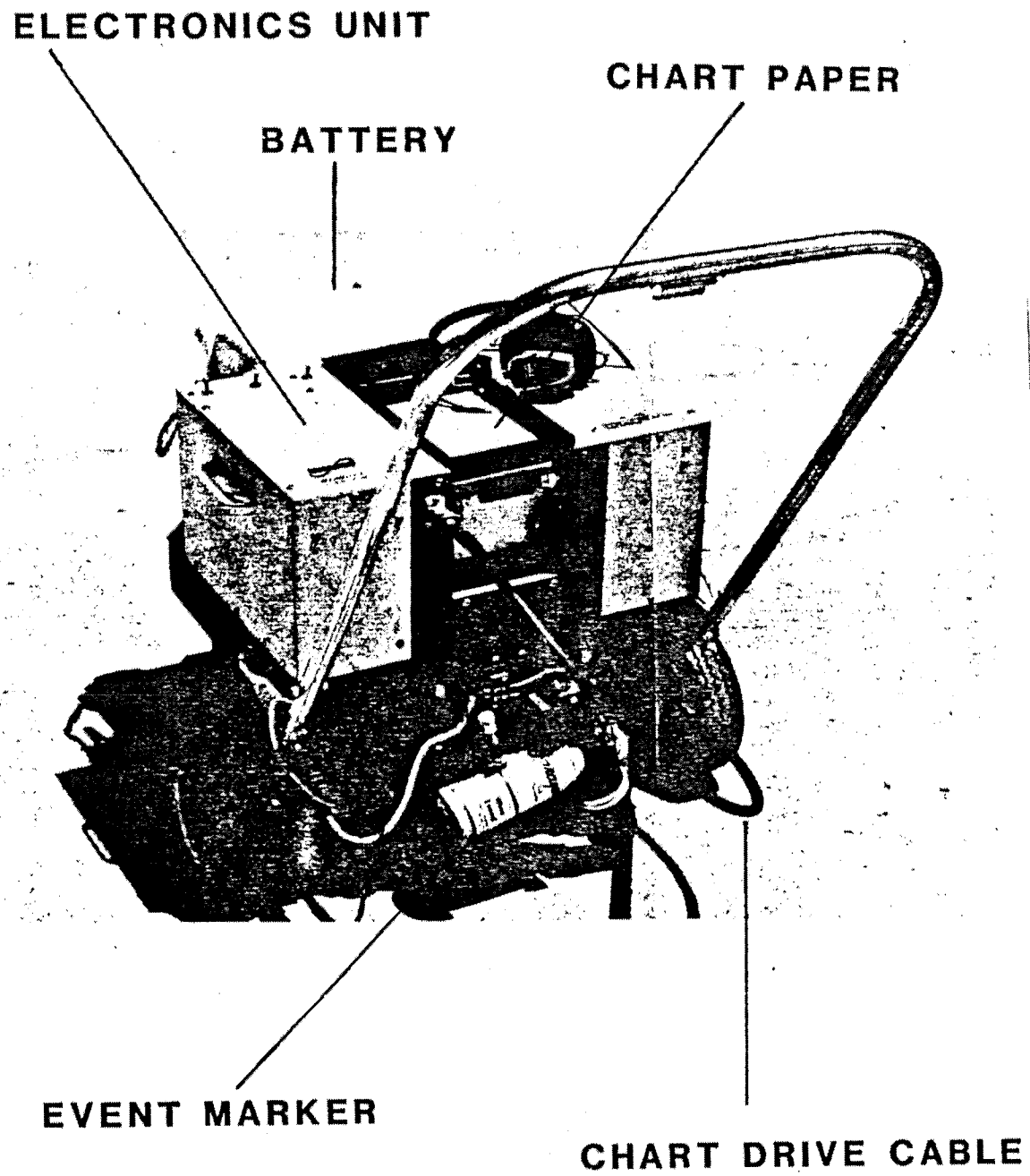


FIGURE 1. OVERALL VIEW OF DELAMTECT

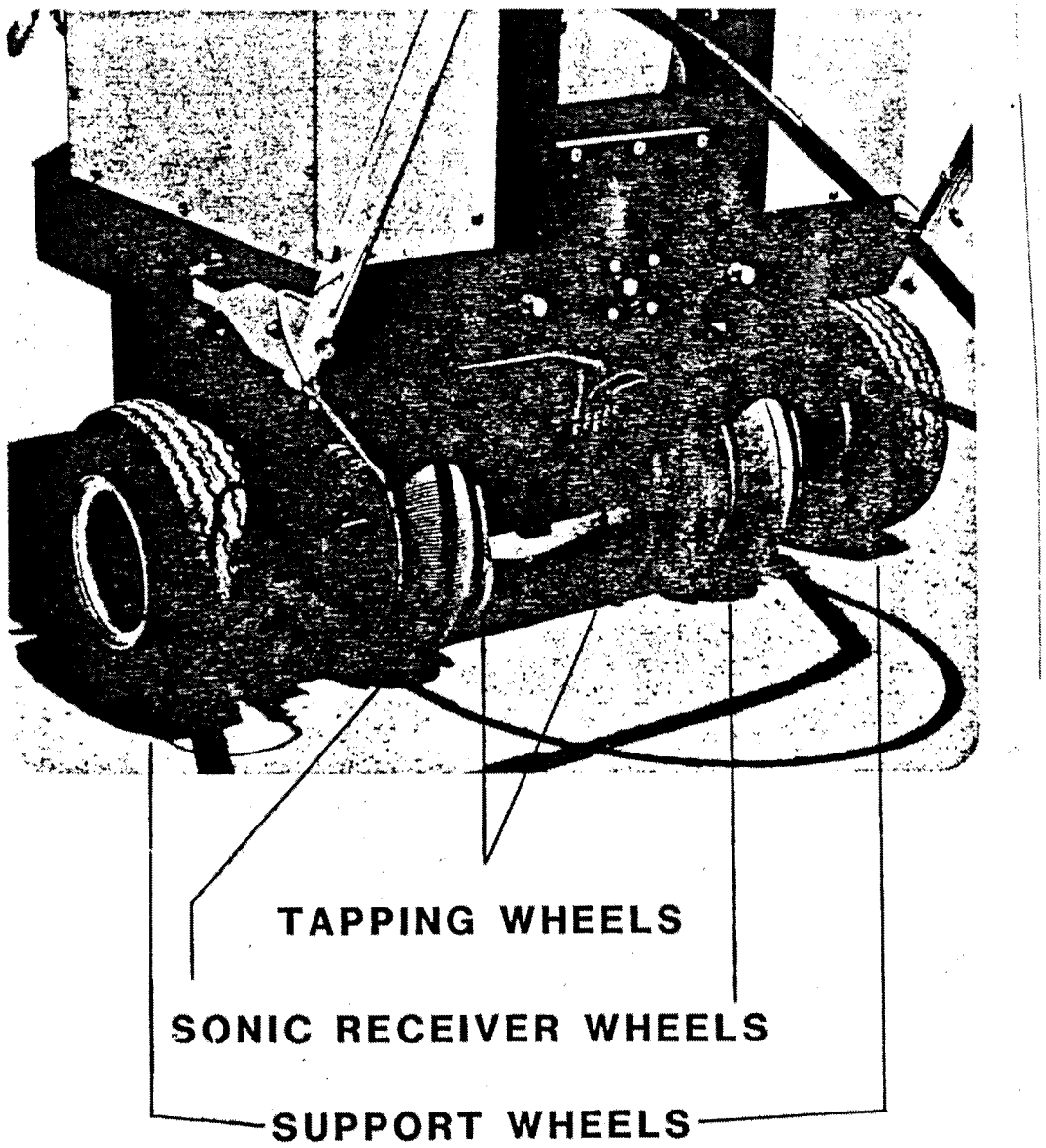


FIGURE 2. DELAMTECT SENSING APPARATUS

As the Delamtect is moved along the deck or pavement an acoustic signal is transmitted into the slab. The tapping device is a pair of small steel-rimmed wheels driven by an oscillating solenoid. The wheels tap against the surface 33 times per second and make a "chattering" noise. The vibrations generated in the concrete are received by a pair of microphones mounted 12 inches apart. The microphones are mounted downward in oil-filled inner tubes. The inner tubes are always in contact with the surface. The receivers have almost no sensitivity to ambient noise or surface texture.

The signals received are interpreted by the electronics unit. The duration of the sonic vibrations is longer from a solid area than from a delaminated area. Vibrations which last more than three milliseconds are ignored. Also, vibrations from delaminated areas tend to range from 300 H_z to 1200 H_z. The apparatus is keyed to ignore frequencies outside this range.

Each of the two sensing wheels surveys a path three inches wide. The paths are separated by six inches. It would require 24 passes to completely survey a 12-foot lane. The manufacturer suggests an adequate survey could be made with four passes with equal spacing. We made six passes so that each channel would represent a one-foot wide path. This covers the surface more completely and simplifies mapping.

Infrared Thermography

The infrared camera is a small lightweight field model that produces a standard video signal which is recorded on tape. The camera is equipped with a mercury cadmium telluride (HgCdTe) sensor which is cooled by liquid nitrogen and is capable of detecting temperature differences of 0.2°C. The camera has an expander lens which provides a view of one and one-quarter lanes, permitting some overlap from lane to lane for analysis purposes and allowing minor lateral vehicle movement during scanning. It is shown in Figure 3.

A conventional color video camera provides a control image. It has a zoom lens to allow the field of view to match the infrared image. Each camera is connected to a monitor and a video cassette recorder inside the van (see Figure 4). An electronic distance measurement device references the image to a known starting point. A surface-reading thermometer is used to measure the temperature at delaminated and solid areas. This is done periodically at areas of suspect delamination to verify that the infrared detection system is operating properly. These areas are also sounded with a hammer.

During operation the infrared and video cameras are mounted approximately seventeen feet above the pavement on a framework at the front of the van. The operator controls the quality of the images on the monitors inside the van. Vehicle speed is kept at a nearly constant five miles per hour along the middle of each test lane. A single pass is made in each lane.

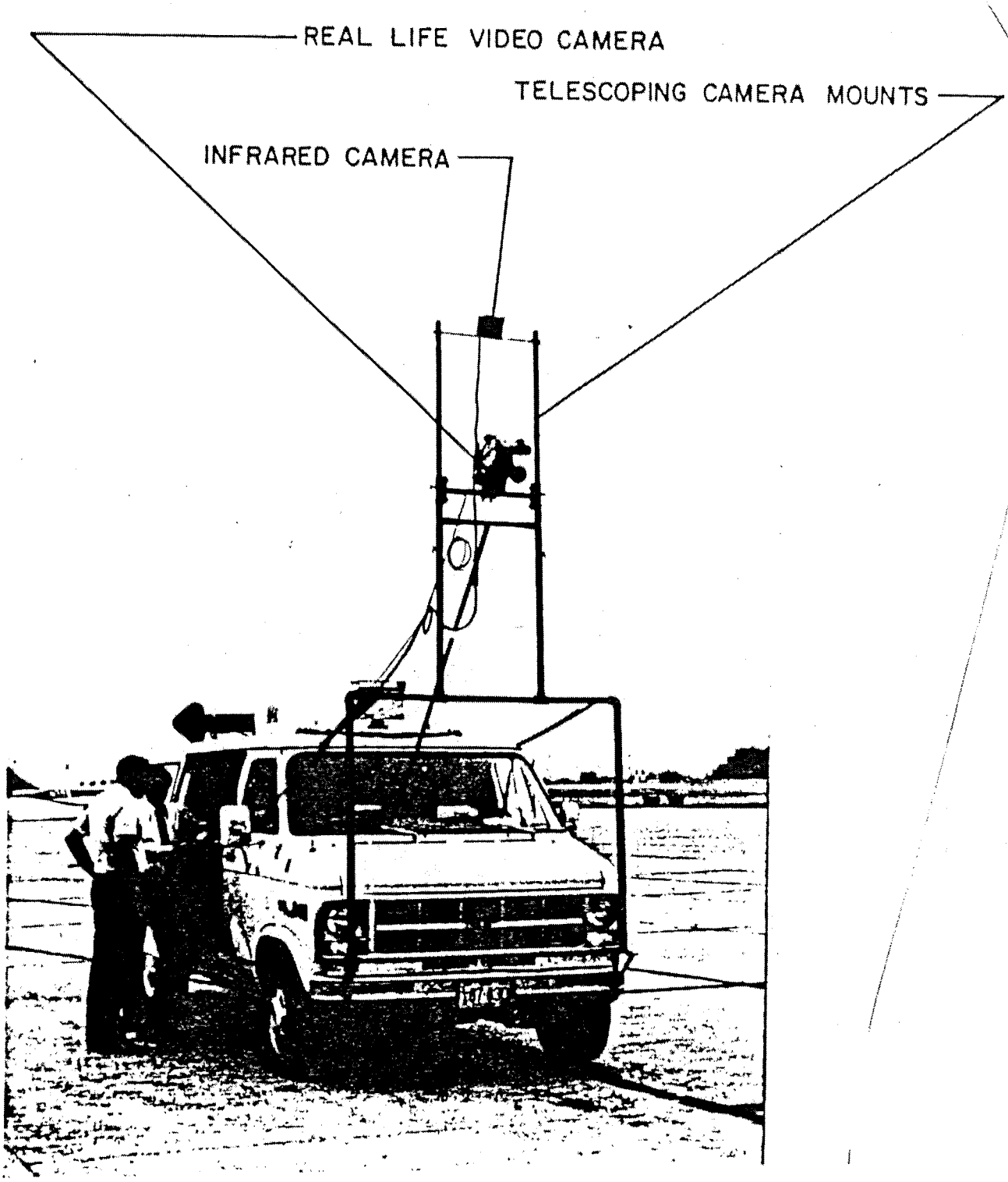


FIGURE 3. THERMOGRAPHY SCAN VEHICLE

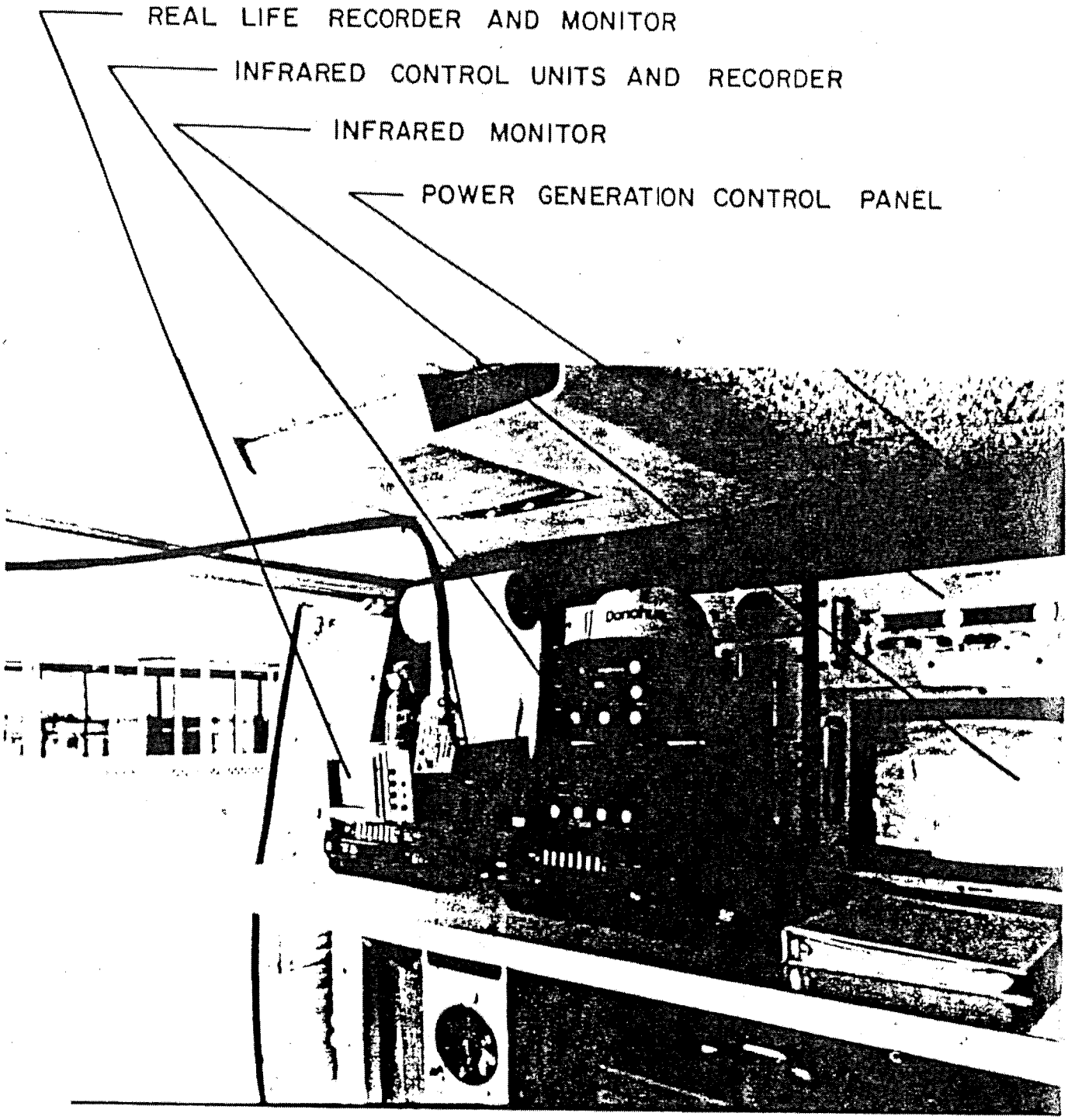


FIGURE 4. INTERIOR OF SCAN VEHICLE

Certain environmental conditions are required for thermography to be effective. Mostly clear skies, winds of less than fifteen miles per hour and dry pavement are necessary. About two hours of sunshine in the morning are desirable to sufficiently warm the pavement. The best times to test are between 9:00 A.M. and 3:00 P.M. If the pavement is wet or not sufficiently warmed, a detectable temperature difference between delaminated and solid areas will not be established.

DATA COLLECTION AND EVALUATION

Delamtect

The Delamtect's chart drive is geared to the rear wheels in a ratio such that one inch of chart paper corresponds to ten feet of machine travel. This feature permits accurate mapping when the charts are analyzed. Each pass of the Delamtect covers a two-foot wide path.

The chart paper is marked to note the beginning and end of each pass. Undelaminated areas are drawn as a relatively smooth line. Some waviness of the line may be produced by a rough surface. A pen deflection of at least one major division on the chart paper will indicate a delamination. The extent of a delamination is measured by the length of the spike, which is the distance between the beginning and end points of the spike. A sample chart is shown in Figure 5.

The percentage of delamination is calculated by summing the lengths of all the spikes and dividing by the total chart paper length. The location of a delamination is determined by its position on the chart paper relative to the length of the chart paper.

Infrared Thermography

The infrared camera produces a black and white image. The solid pavement, being relatively cool, shows up as a dark area. The warmer delaminations are lighter shaded areas. Asphalt patches, oil stains, and loose sand and gravel also show up as light areas. Figure 6 shows the view as seen by the infrared camera.

The distance traveled in feet is displayed on the infrared monitor and recorded along with the infrared image. This allows the size and relative location of delaminations to be determined.

When the video tapes are analyzed a photographic strip chart is produced. Resolution is slightly better on the original video tape. Suspect delaminations are noted on the strip chart and transferred to a plan sheet. The control video tape is examined to be sure the suspect delaminations are not discolorations, patches, or debris.

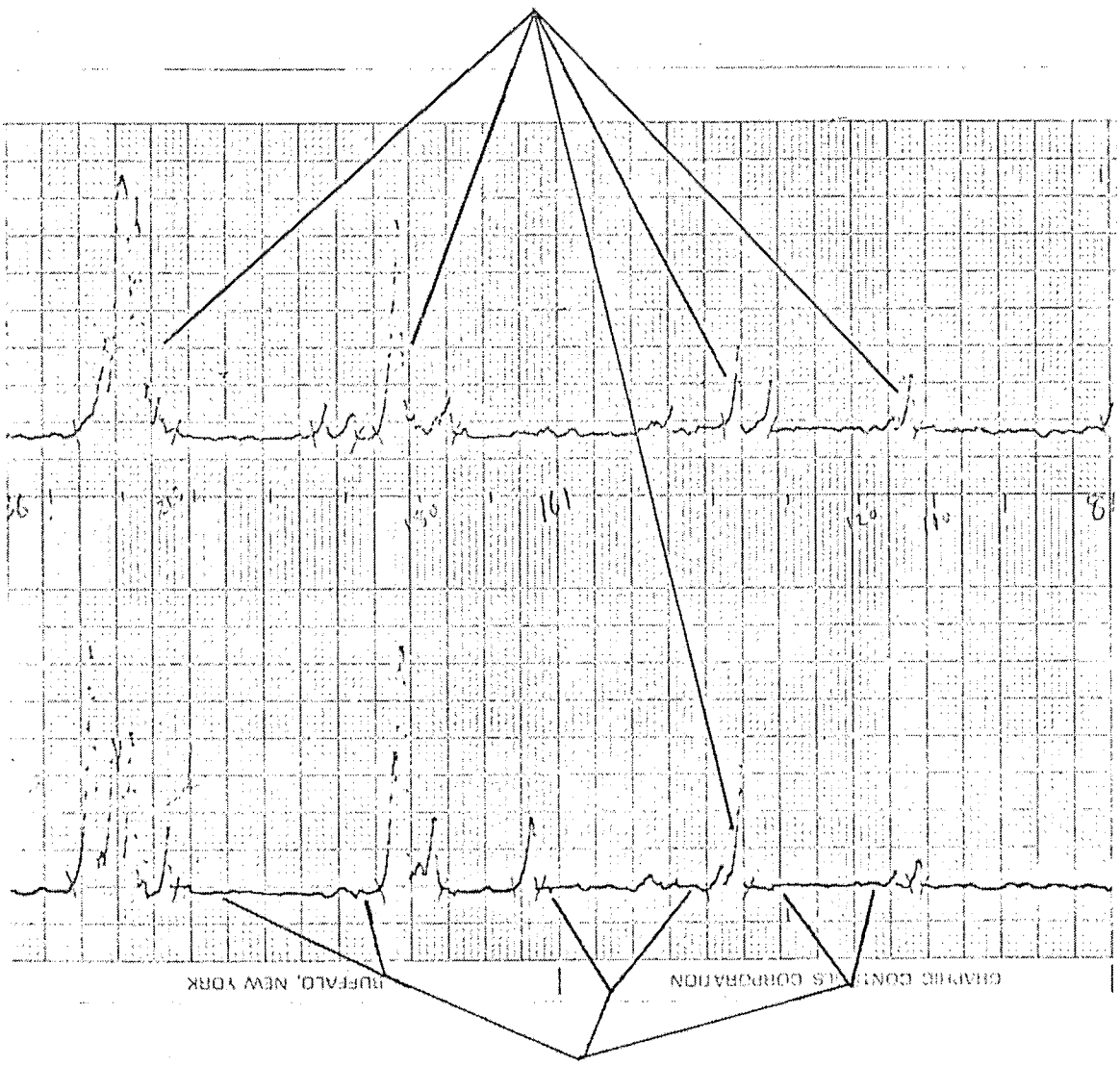


FIGURE 5. EXAMPLE OF DELAMTECT CHART PAPER

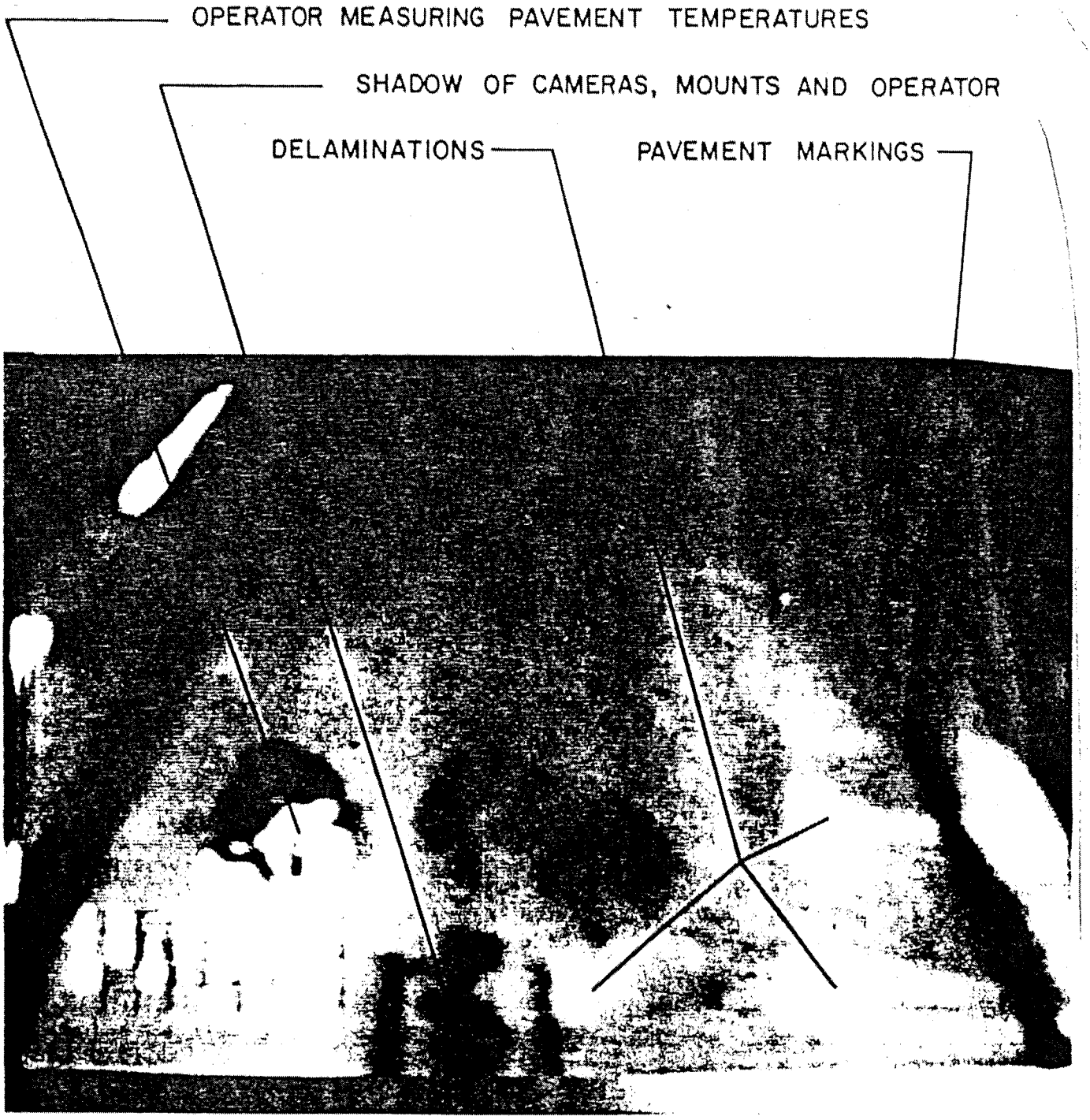


FIGURE 6. INFRARED CAMERA VIEW OF PAVEMENT

RESULTS

Three sections of CRCP and two bridge decks were surveyed using infrared thermography and the Delamtect. The bridge decks were also chain dragged.

Southbound I-35W

Three short sections which were tested with the Delamtect were part of a one-mile length of CRCP in Blaine surveyed by infrared thermography on June 22, 1983. Thermography was used on both the passing lane and the driving lane. Only the driving lane was surveyed with the Delamtect. Figures 7, 8, and 9 illustrate the test results. Zones 3 and 8 are each 100 feet long and are part of a cathodic protection system installed in 1978. The 140-foot long control section is about 700 feet north of the cathodic protection area.

The results of Delamtect and infrared thermography surveys matched quite well. There were few unsound areas in the two zones under cathodic protection. Thermography found some small delaminations that were missed by the Delamtect. All delaminations located by the Delamtect were also found by thermography.

The control section was more extensively delaminated. The Delamtect appears to have found more unsound areas than did thermography. The reason for this is that thermography discriminates patches from delaminations and the Delamtect does not. Asphalt patches are typically read by the Delamtect as being unsound. If the patches are included with the delaminations located by thermography then the two methods match fairly well in this section.

Park Avenue over I-35W/I-94

This four-lane bridge carries Park Avenue over I-94/I-35W in Minneapolis. It was surveyed with infrared thermography and the Delamtect on August 5, 1983. A spot survey with the chain drag was done in the spring.

No mapping was available from the chain drag survey, but the survey did indicate about 40% of the south half of the deck and 10%-15% of the north half to be delaminated. These results agree quite closely with the Delamtect and are somewhat higher compared with thermography.

Infrared thermography found 10.1% of the deck area to be delaminated. Another 13.4% was patched. The Delamtect found 21.2% of the deck area to be delaminated. The results are shown in Figures 10 and 11. This deck has been patched with both concrete and bituminous. Concrete patches are usually sound and bituminous patches unsound when surveyed with the Delamtect. If the bituminous patches are included with the delaminations found by infrared thermography the results would compare favorably with the Delamtect findings.

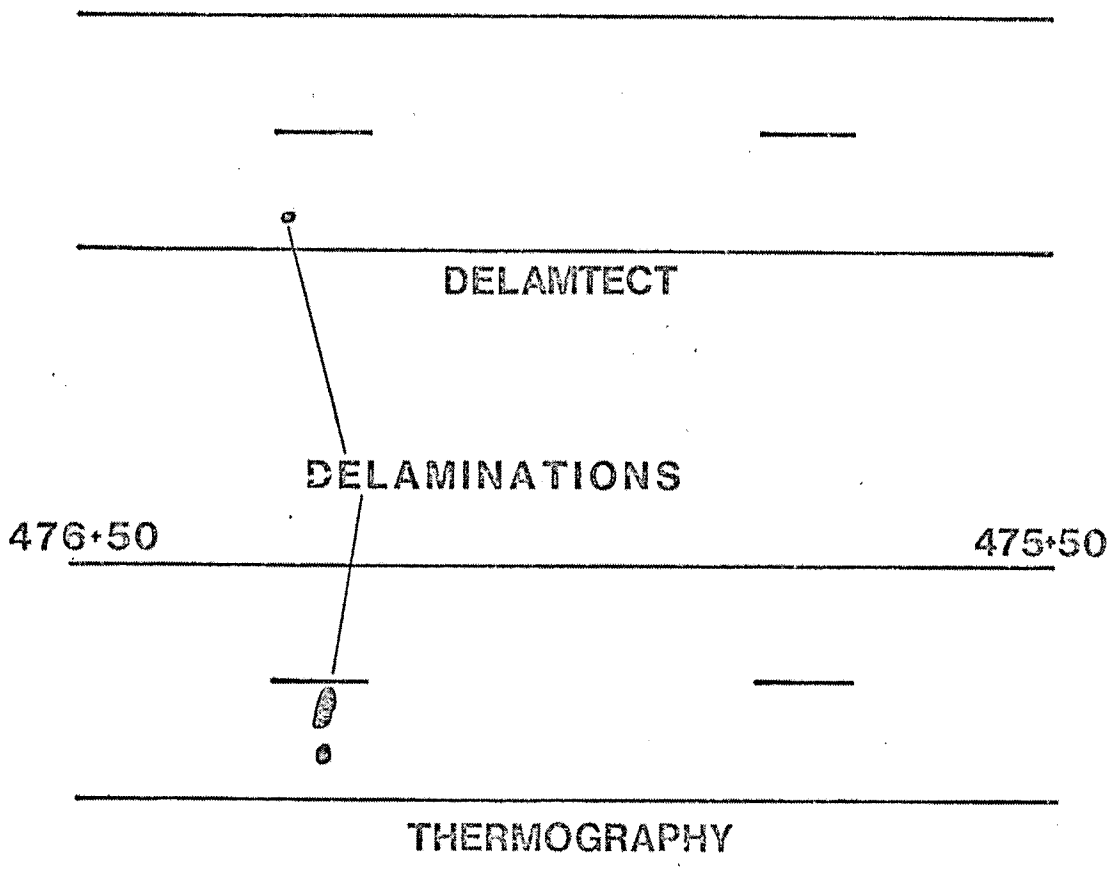


FIGURE 7. I-35W CATHODIC PROTECTION ZONE 3

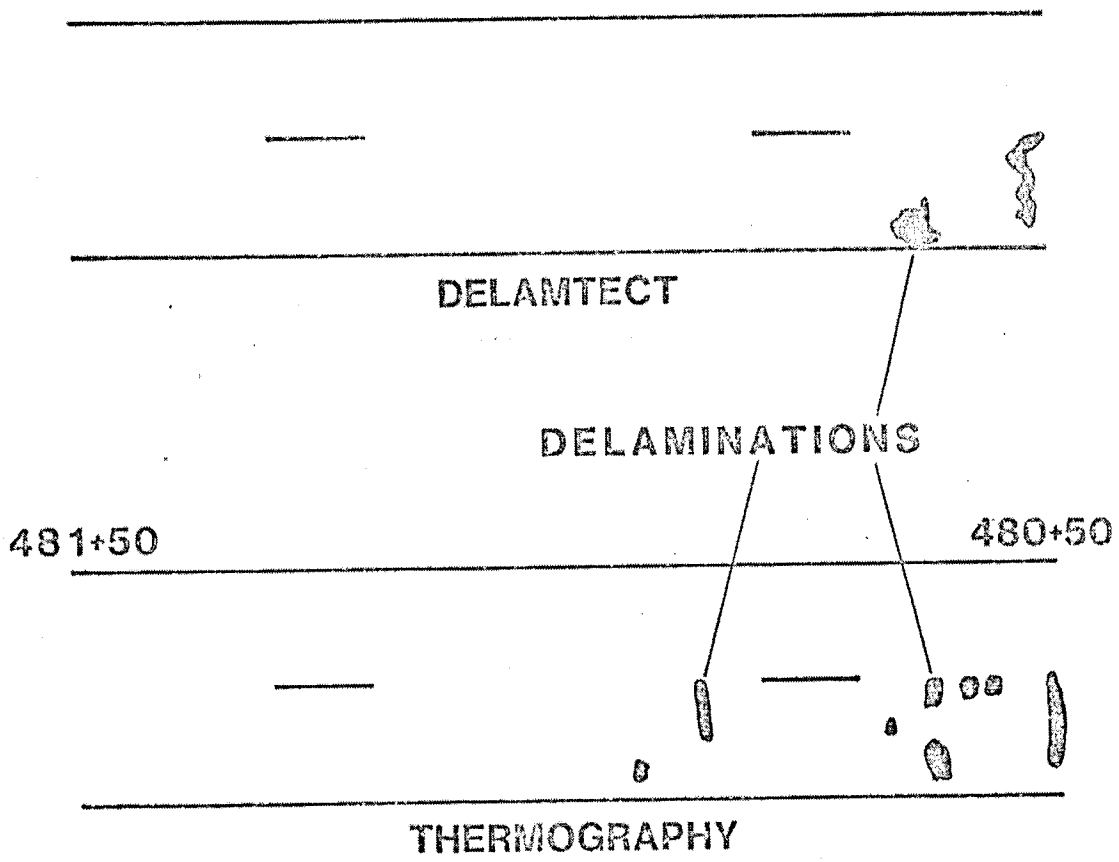
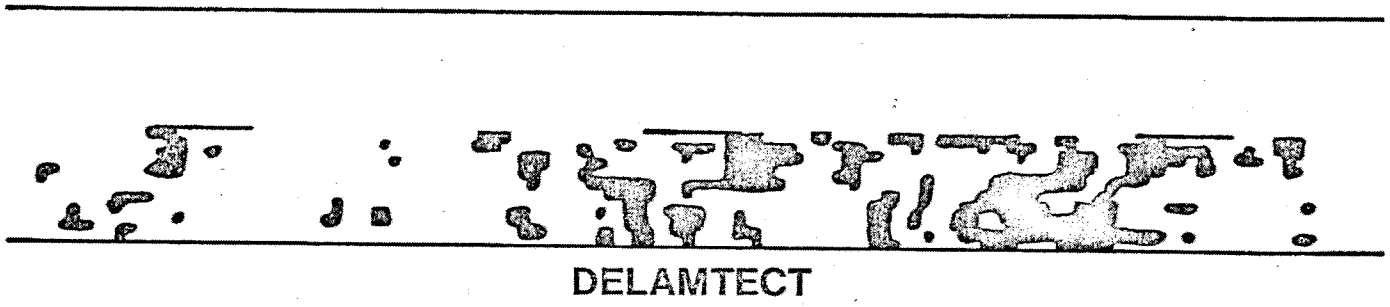


FIGURE 8. I-35W CATHODIC PROTECTION ZONE 8



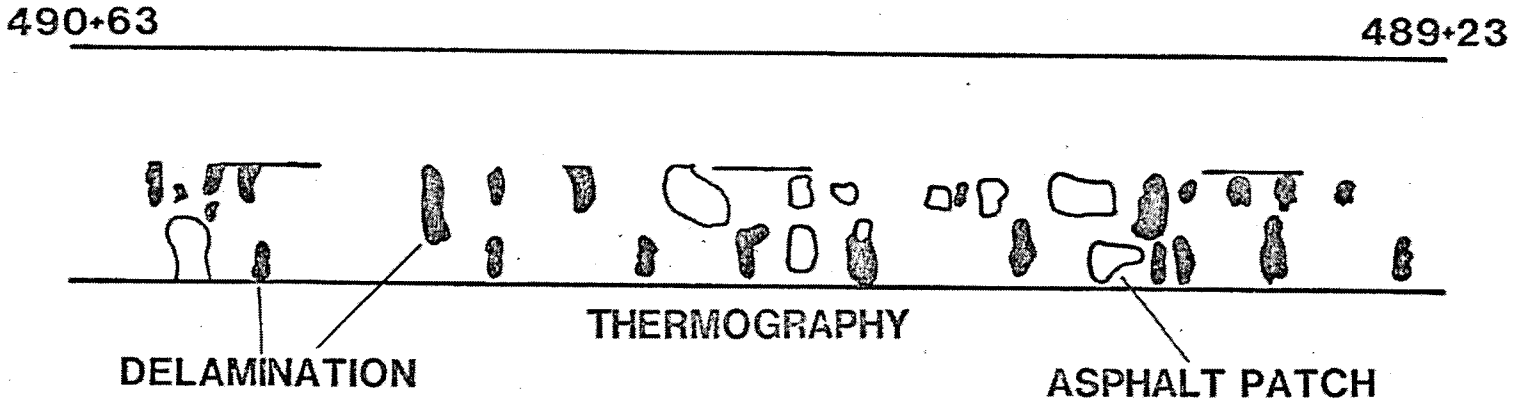


FIGURE 9. I-35W CONTROL SECTION 3

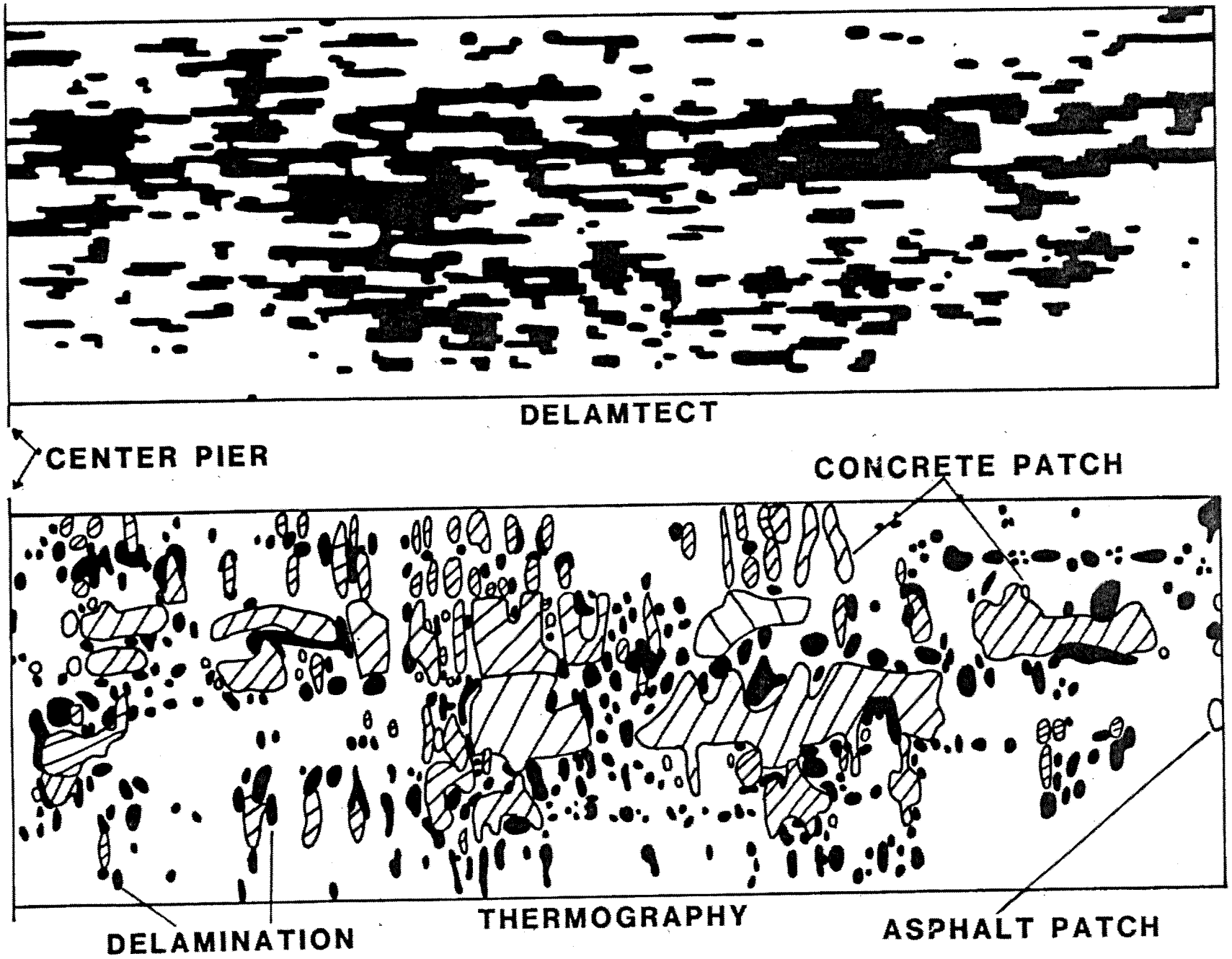


FIGURE 10. PARK AVENUE OVER I-35W/I-94 - SOUTH HALF

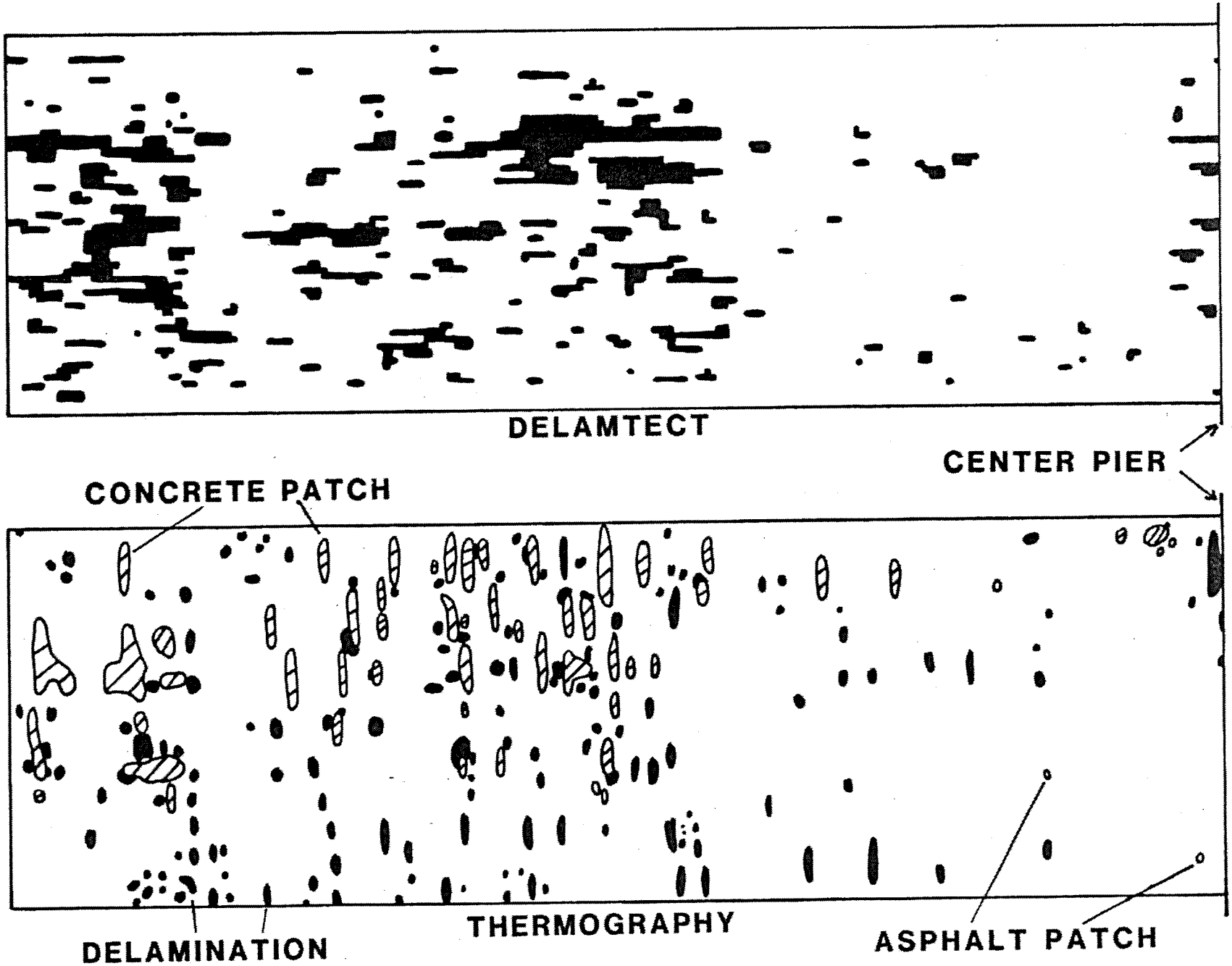


FIGURE 11. PARK AVENUE OVER I-35W/I-94 - NORTH HALF

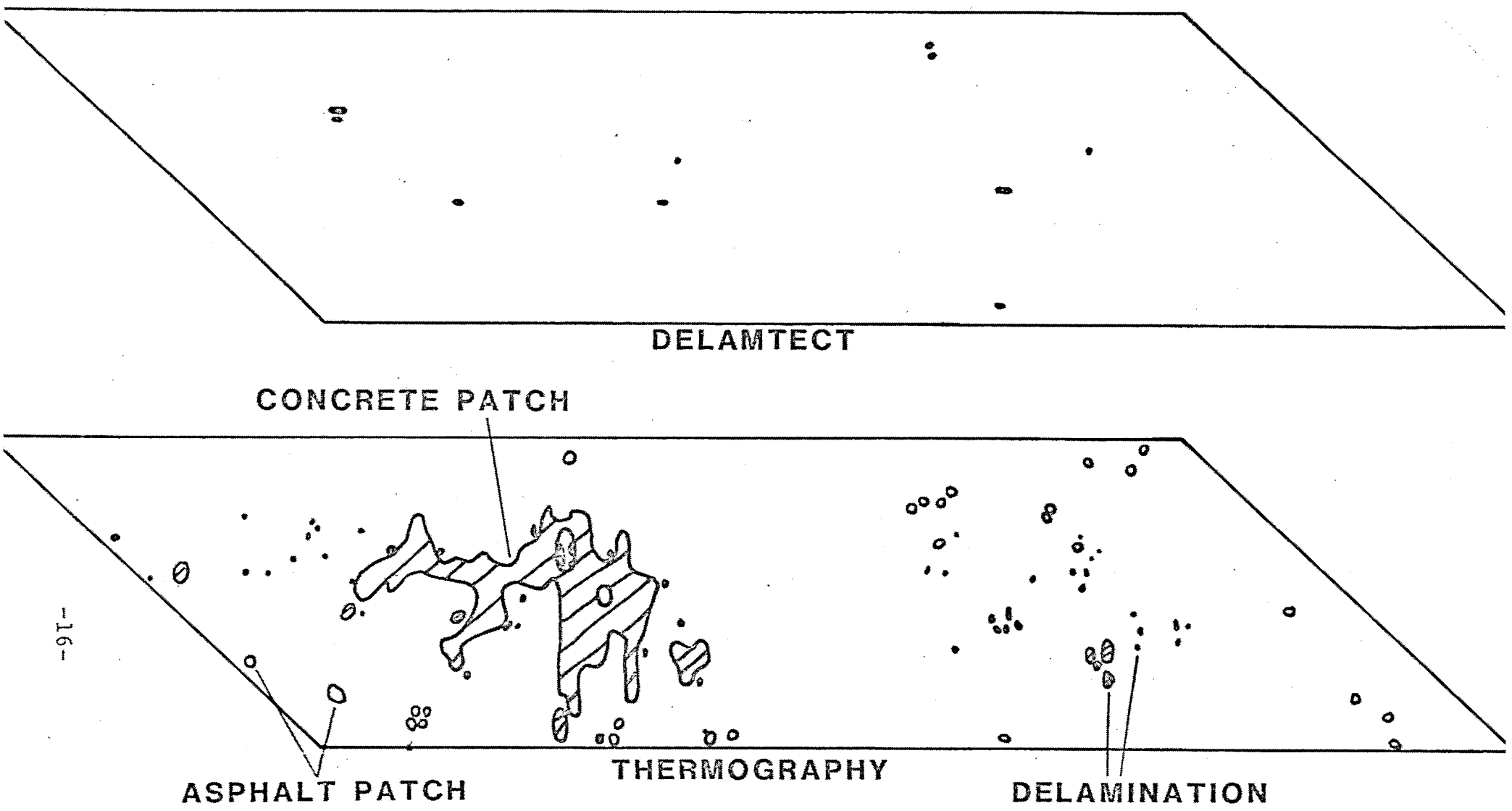


FIGURE 12. FRANKLIN AVENUE OVER I-94

Franklin Avenue over I-94

This is a two-lane bridge over I-94 in Minneapolis. Infrared thermography and Delamtect surveys were done on August 5, 1983. A chain drag survey had been done earlier in the year.

The chain drag and thermography surveys agreed very closely on the amount of delamination present. Both found 0.9% of the total deck area to be delamination, the chain drag locating 70 square feet and infrared thermography 65 square feet. The Delamtect found slightly less, 0.5% and 37 square feet. The results are illustrated in Figure 12.

There were some difficulties which hampered the Delamtect on this deck. The delaminations were very small and easy to miss. Also, the lack of lane markings made it difficult to follow a straight path.

CONCLUSIONS

Several conclusions and observations may be reached from the comparison of the Delamtect and infrared thermography.

1. Both methods appear to provide an accurate picture of the extent of delamination in a bridge deck or pavement. Infrared thermography can scan an entire lane in one pass and thus can show a better picture of the shape of the delaminations. The Delamtect surveys several narrow paths which must be assembled to make a total picture.

2. Surveys can be made faster with infrared thermography. A lane closure is required for both methods. A moving lane closure can be used when surveying a length of pavement with infrared thermography. Practical use of the Delamtect is limited to bridge decks and short pavement sections.

3. Infrared thermography can distinguish between different types of unsound areas, such as delaminations, spalled areas, and patches. The Delamtect will tell only if an area is sound or unsound.

4. Infrared thermography is sensitive to environmental conditions. If the sky is overcast or if the surface is wet, thermography will not work. The Delamtect is not subject to these restrictions.

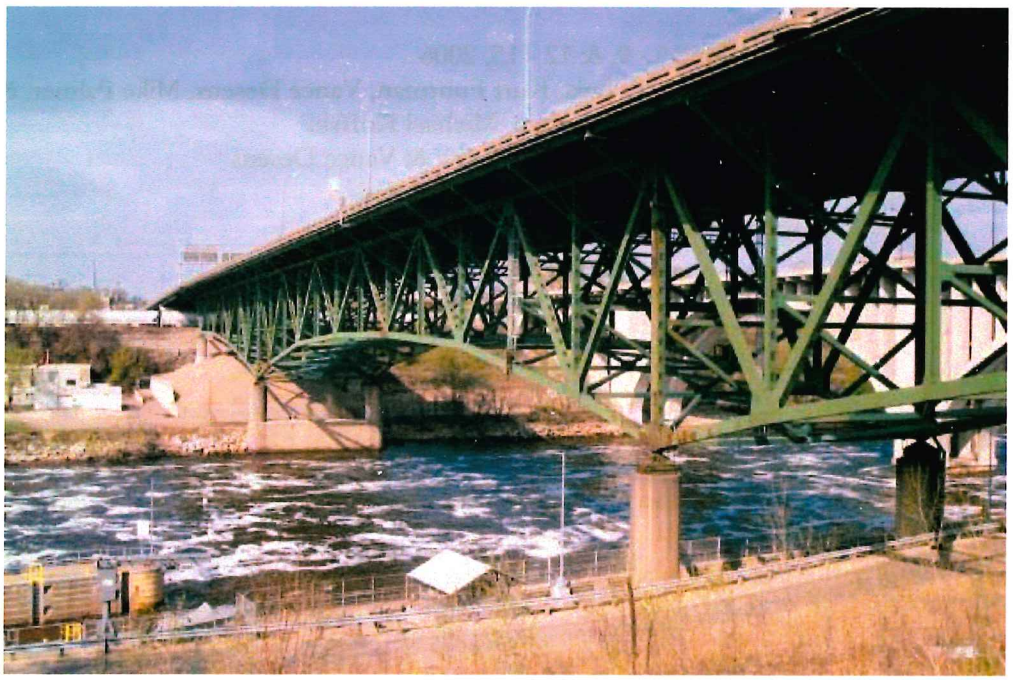
5. Both methods reveal the actual percentage of surface area that is delaminated. Thermography shows the shape of the delaminations better than the Delamtect does. Removal quantities for contract work must be "squared out" and may be as much as three times the actual delaminated area.

6. It appears that less operator judgement is required to analyze video tapes than to examine and calculate Delamtect charts.

7. It is possible for the Delamtect to miss small delaminations. With its wider scanning area infrared thermography appears to be able to "see" all the delaminations.

FRACTURE CRITICAL BRIDGE INSPECTION

In-Depth Report



BRIDGE # 9340 (SQUIRT BRIDGE)

I-35W over the Mississippi River at Minneapolis, MN

JUNE 2006

Prepared For

Minnesota Department of Transportation
Office of Bridges & Structures

Prepared By

Minnesota Department of Transportation Metro District
Maintenance Operations, Bridge Inspection

STRUCTURE INVESTIGATION INFORMATION

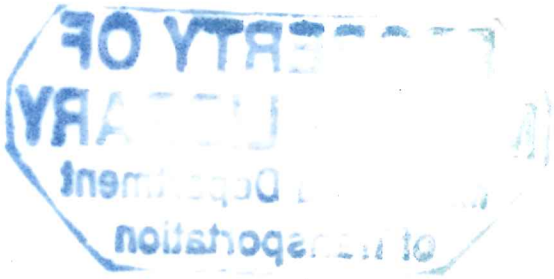
MN/DOT BRIDGE #9340 (SQUIRT BRIDGE)
I-35W OVER THE MISSISSIPPI RIVER AT MINNEAPOLIS, MN

JUNE 2006

Inspection Date: June 5 - 9, & 12 - 15, 2006
Inspection Team: Mark Pribula, Kurt Fuhrman, Vance Desens, Mike Palmer, & Khaled Shouman, Michael Koffski
Inspection Report Author: Kurt Fuhrman & Vance Desens
Bridge Maintenance Sub Area: Spring Lake Park
Access Equipment Used: Aspen A75 (Mn/DOT)
Reach-All UB50 (Mn/DOT)

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Registered Licensed Professional Engineer under the laws of the State of Minnesota

Mark Pribula	21102 Registration No.	Date



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EXECUTIVE SUMMARY

The "Federal Aid Highway Act of 1968" directed the establishment a national bridge inspection program. Accordingly, the Minnesota Department of Transportation, Metro Division Bridge Inspection Unit conducted an annual inspection of Bridge # 9340 over the Mississippi River at Minneapolis, MN. The bridge also crosses over several roadways, Minnesota Commercial Railroad tracks, & parking lots.

Constructed in 1967, the bridge has 14 spans, with a total length of 1,907 feet. The split deck has three through lanes each direction with acceleration/deceleration lanes and 2 ft. shoulders. The bridge deck widens at the north end to accommodate on & off ramps, and curves slightly at the south end. Spans #6 - 8, the main river spans, are "Fracture Critical" steel deck trusses. They are comprised of welded "built-up" members and are 988 ft. long. The truss is approximately 60 ft. deep at piers #6 & 7. The two main trusses are connected by welded floor beam trusses, which cantilever beyond the truss on both sides and support the 27" deep rolled beam roadway stringers. At each end of the main truss spans, the truss supports the adjacent approach spans with a unique "crossbeam" configuration. The approach span beams frame into a "crossbeam", which is supported by rocker bearings on the cantilever truss ends. Spans #1 - 5 & 9 - 11, the approach spans, have 48" deep, welded plate beams, which transition into 33" deep welded & rolled steel beams. Connections are riveted. Spans #12 - 14, the far north spans, are cast-in-place concrete voided slabs.

Due to several factors, including mist from nearby St. Anthony Falls, the bridge deck frequently ices over and becomes quite treacherous. In 1999, an automated de-icing system was installed on the deck with spray nozzles installed in the deck and railings. The systems controls and storage tanks are located on the north end just off the freeway entrance ramp from East University to South I-35W.

- If bridge replacement is significantly delayed, the bridge should be re-decked. The design of the main river spans do not allow for deck widening. Any re-decking contract should also include a complete re-painting of the superstructure, elimination of the hinge joint in span #2, and reconfiguration of the deck drainage system.

- Every two years the plastic pigeon screens are removed on all tension and reversal members to visually inspect the truss box girder member's internal diaphragms. Any questionable welding flaws discovered during this inspection were tested with magnetic particle equipment.

- Fatigue cracks at girder #1C (NBL), crack at the diaphragm bottom cutout, NE side measures 2" ("front face") and NW side measures 2-½" ("back face"). Fatigue cracks a girder #3 (NBL), crack at the diaphragm bottom cutout, measures 1-½" (both sides). The cracks are located in negative moment regions where the diaphragm web stiffener was not welded to the top flange and were pervious fatigue cracks occurred and were repaired in 1998 and 1999. These areas should be inspected next year for any lengthening of the cracks and drilling of possible stress relief holes.

- Span 3, stringer #7 NB, has a 1-½" crack in the web with one 2" hole drilled. It is recommended to drill a 2" hole at the other end.

- During the 1998 inspection, numerous fatigue cracks were found in spans #3 - 5 and #9 - 10, the approach spans. The cracks were located in negative moment regions where the diaphragm web stiffener was not welded to the top flange. At one location the web had cracked through entirely. Most existing cracks were drilled out, and the fractured beam was reinforced with bolted plates. To reduce the stress levels, the diaphragms were lowered. Due to the widespread cracking, these areas should be inspected in-depth on an annual basis.

BRIDGE INSPECTION RECOMMENDATIONS

This recommendation listing refers to specific areas where fatigue cracks and other deficiencies were located during the 2006 inspection. Bridge inspection lists these deficiencies in the highest priority first.

Long Term Repair Recommendations

- The long term plans for this river crossing need to be defined with replacement, re-decking, etc. Due to the "Fracture Critical" configuration of the main river spans and the problematic "crossbeam" details, and fatigue cracking in the approach spans, eventual replacement of the entire structure would be preferable.

- If bridge replacement is significantly delayed, the bridge should be re-decked. The design of the main river spans do not allow for deck widening. Any re-decking contract should also include a complete re-painting of the superstructure, elimination of the hinge joint in span #2, and reconfiguration of the deck drainage system.

- Depending on the projected date of bridge replacement, the bridge deck will eventually require a partial overlay repair contract. The expansion joints should also be replaced.

Immediate Maintenance Recommendations

- Every two years the plastic pigeon screens are removed on all tension and reversal members to visually inspect the truss box girder member's internal diaphragms. Any questionable welding flaws discovered during this inspection were tested with magnetic particle equipment.

- Fatigue cracks at girder #1C (NBL), crack at the diaphragm bottom cutout, NE side measures 2" ("front face") and NW side measures 2-½" ("back face"). Fatigue cracks a girder #3 (NBL), crack at the diaphragm bottom cutout, measures 1-½" (both sides). The cracks are located in negative moment regions where the diaphragm web stiffener was not welded to the top flange and were pervious fatigue cracks occurred and were repaired in 1998 and 1999. These areas should be inspected next year for any lengthening of the cracks and drilling of possible stress relief holes.

- Four-stringer connection bolts, all in the NBL, need replacement. At panel point #8, stringer #2 has 2 loose bolts, and the bearing block has rotated. This will likely require jacking the superstructure. Stringer bolts also need replacement at panel point #8, stringer #4, south side, and at panel point #11, stringer #3.

- Several strip seal joints are leaking. The glands have ripped or pulled out. Attempts were made to replace these joints during the 1998 repair contract, but the steel extrusions, which anchor the gland, had severe corrosion, and new glands could not be installed. Instead, a new product was used at the, SBL, south abutment. This utilized a hot pour seal with wire mesh reinforcing. The final product looks similar to a strip seal gland. We should monitor this joint to see how well this new gland repair performs, and consider using it at other locations.

- The rubber "skirts" sections above the truss end rockers, installed in 1999, tend to fill with debris. These should be flushed out annually. The horizontal drain troughs at pier #6 have inadequate slope, and are clogged.

Areas of Concern - Future Inspections

- Span 3, stringer #7 NB, has a 1-½" crack in the web with one 2" hole drilled. It is recommended to drill a 2" hole at the other end.

- During the 1998 inspection, numerous fatigue cracks were found in spans #3 - 5 and #9 - 10, the approach spans. The cracks were located in negative moment regions where the diaphragm web stiffener was not welded to the top flange. At one location the web had cracked through entirely. Most existing cracks were drilled out, and the fractured beam was reinforced with bolted plates. To reduce the stress levels, the diaphragms were lowered. Due to the widespread cracking, these areas should be inspected in-depth on an annual basis.

- The truss end rocker bearings & main truss bearings should be measured for movement during each annual inspection. The truss end floor beams & approach end "crossbeams" should be closely inspected. They have section loss, had flaking rust & fatigue cracks (open finger joint).

- The hinge joint in span #2 is locked in full expansion several beam-ends are contacting, and the hinge bearings are "frozen" and no longer functioning. Consequently, pier #1 has tipped slightly to the north, and the south abutment bearings are in full contraction. This area should be thoroughly inspected.

For information that is more detailed and recommendations, please refer to the appropriate sections in the text of the report.

BRIDGE DESCRIPTION

Bridge #9340 was constructed in 1967, and has 14 spans, with a total length of 1,907 feet. The split deck has three through lanes each direction & also acceleration/deceleration lanes. The shoulders are only 2 ft. wide. The bridge deck widens at the north end to accommodate on & off ramps, and curves slightly at the south end.

Spans #6 - 8 are "Fracture Critical" steel deck trusses, comprised of "built-up" welded members. Steel deck truss spans are 988 ft long. Span #7 is 456 ft. long. The truss is approximately 60 ft. deep at piers #6 & 7. The two main trusses are connected by welded floor beam trusses, which cantilever beyond the truss on both sides, and support the 27" deep rolled beams roadway stringers.

At each end of the main truss spans, the truss supports the adjacent approach spans with a unique "crossbeam" configuration, (open finger joint). The approach span beams frame into a "crossbeam", which is supported by rocker bearings on the cantilever truss ends. Spans #1 - 5 & 9 - 11, the approach spans, have 48" deep welded plate beams, which transition into 33" deep welded & rolled steel beams. The connections are riveted. Spans #12 - 14, the far north spans, are cast-in-place concrete voided slabs.

Due to several factors, including mist from nearby St. Anthony Falls, the bridge deck frequently ices over and becomes quite treacherous. In 1999, an automated de-icing system was installed on the deck, with spray nozzles installed in the deck and railings. Control room is located at the northwest approach corner.

BRIDGE DECK: NBI CONDITION CODE 5

Split deck has 3 through lanes each direction, with acceleration/deceleration lanes. Shoulders are only 2 ft. wide. A low slump concrete overlay, with numerous full-depth deck repairs, was placed on the deck in 1978. In 1998, the median copings were replaced with steel stay-in-place forms, and the exterior copings were patched with shot-crete.

Wearing Surface: Overlay has some minor spalls and patched areas around the finger joints, and 3,000 LF of transverse cracks, sealed in 1998. The overlay has several patched areas, and some spalls. Additional patching is typically required each year. A partial chaining of the northbound deck in 1998 found 1,665 SF of delamination & 47 SF of spall. In 1999, the Federal Highway Administration conducted a ground penetrating radar survey, using the experimental "HERMES" system. The radar survey found the overlay to have 6.14% delamination. [2001] Overlay has 15,250 SF of concrete repair patches.

Structural Slab: Underside of the deck has a moderate amount of transverse leaching cracks, with some areas of leaching map cracks & spalling, particularly in the south approach spans. In 1998, the median coping overhangs were replaced with steel stay-in-place forms, and the exterior copings were repaired with shotcrete. During the median slab removal, the bays adjacent to the median were damaged - some of the "stool" concrete along the stringers & beams has spalled off with exposed rebar; and in some locations, the spalling extends into the underside of the deck. [2001] Structural slab has 1,200 SF full depth repair patches.

Open Finger Expansion Joints: Deck has three open finger joints, one above the hinge joint in span #2, & one at each end of the truss spans. In 1999, rubber "skirts" were installed below the truss end finger joints & the drain troughs were removed.

Strip Seal Expansion Joints: Strip seal, type "H" joints at the abutments, pier #11, and at five stringer joints in the main truss spans. These were installed in 1978. Strip seal glands have pulled out, with joints leaking, in several locations. Steel extrusions, which anchor the glands, have severe section loss, making gland replacement impossible. In 1998, the south abutment, SBL, gland was patched using an experimental system. Hot poured seal with wire mesh reinforcement.

Poured Deck Joints: The deck has several transverse poured joints, from staged deck construction. All of these joints are leaching below; & at some joints the deck is spalling below.

Exterior Railings: The original exterior code #12 railings were retrofit in 1998. A 32" high concrete face was installed in front of the existing concrete rail base. The horizontal steel rails were removed. The curb along the railing has moderate cracking, delamination and spalling. The curb has 800 LF reconstructed in 2001.

Median Railings: Code #22, type "J"-rail, was installed along the split median in 1998. The railings above the truss spans have removable pre-cast concrete caps, which are intended to prevent further corrosion damage to the superstructure below.

BRIDGE SUPERSTRUCTURE: NBI CONDITION CODE 4

Paint System: Bridge was originally painted with a lead base system in 1968. In 1999, the bridge was partially re-painted with a zinc system. Areas painted included the entire superstructure below and along the open median, and below the open finger deck joints.

Currently, the overall paint system is approximately 15% unsound. The truss members have surface rust corrosion and pack rust at the floorbeam & sway frame connections, and there is paint failure & surface rust corrosion in scattered locations. The floorbeam trusses & stringer ends have surface rust corrosion at the stringer expansion joints. Some of the areas re-painted in 1999 have severe section loss. This includes the sections of the floorbeam trusses & sway bracing located below the median, and the truss end floor beams & "crossbeams", located below the open finger joints.

Main Truss Members The two steel deck trusses are comprised of "built-up" welded members; connections include both rivets and bolts. While most truss members are welded box beams, some tension vertical & diagonal members are welded "H" beams. The truss members have numerous poor weld details. The vertical "H" beam truss members have transverse welds at the floor beam connections. The box beam truss members have welded interior stiffeners. Some of these have tack-welded tabs. Many of these tack welds have cracked. Some box beams have tack welds, or tack welded backer bars along the interior corners. The truss members have surface rust corrosion at the floor beam and sway frame connections. Pack rust is forming between the connection plates. There is paint failure,

surface rust, and section loss, flaking rust in scattered locations. The interiors of the box members have severe pigeon debris. In 1999, screens were placed over openings in the truss members to prevent pigeon access. This unfortunately prevents inspection of the interiors. During the 2004 inspection, & every two years after, the plastic pigeon screens are removed on all tension and reversal members to visually inspect the member's internal diaphragms. Any questionable welding flaws discovered during this inspection were tested with magnetic particle equipment.

Floor Beam Trusses: There are 27 floorbeam trusses connecting the main deck trusses. These trusses are comprised of rolled H-beams with welded connections. The floorbeam trusses cantilever beyond the main truss on both sides. They are connected to the main truss, vertical members with bolts & rivets. The floorbeam truss members have numerous poor welding details, including plug welded web reinforcement plates, and tack welds & welded connection plates located in tension zones. Some of the top chord splices are offset vertically, up to ½" – from original construction. The splice plates are bent. The floorbeam trusses below stringer joints have section loss, severe flaking rust. There is pack rust and surface pitting at the main truss connections. In 1999, the floor beam sections below the median were re-painted. Some areas have section loss with holes.

Stringers: There are 14 steel stringers, 27" deep rolled beams, bearing on the floorbeam trusses. They are continuous except for five stringer expansion joints. The stringer ends have surface rust corrosion at the expansion joints. The stringers adjacent to the median were re-painted in 1999. The bolted connections to the floorbeam trusses are "working" and some bolts are loose or missing. [2006] Fascia stringers have minor section loss, with moderate flaking rust along the bottom flange.

Lateral & Sway Bracing: The main deck trusses have both upper and lower horizontal diagonal bracing. There is also a vertical sway frame running below each floorbeam truss - the median portion of these sway frames were re-painted in 1999, some areas have section loss with holes. Each floorbeam truss has 2 diagonal braces, which connect the bottom chord to stringers #4 & 11. The pinned connections on these braces are "working" and at least one cotter pin is missing.

Truss Bearing Assemblies: The truss spans have six "geared roller-nest" bearing assemblies, and two fixed bearing assemblies. The truss bearings have section loss, flaking & surface rust; moderate corrosion, the bearings at piers #5 & 8 are functioning properly. They are checked during each annual inspection. The bearings at pier #6 show no obvious signs of movement, difficult to reach with snooper.

End Floor Beams & Crossbeams: At each end of the main truss, the multi-beam approach spans terminate by framing into a "crossbeam". The crossbeams are supported by rocker bearings mounted on the cantilever truss ends. There is an open finger expansion joint above these members, severe section loss on steel. This area was re-painted in 1998 - 1999, and rubber "skirts" were installed below the finger joint in an attempt to prevent future corrosion damage.

End Floor Beams: The two end floor beams are welded plate girders. They connect the main truss ends. The end floor beams were re-painted in 1998/1999. The sides facing the open finger joints have extensive section loss with surface pitting at the base of the web, and

holes in the base of the vertical stiffeners. In 1998, fatigue cracks were found in two stiffener welds directly above the NE rocker bearing.

Crossbeams & Rocker Bearings: The two "cross-beams" are welded plate girders each one is supported by two "rocker" bearings attached to the cantilever ends of the main truss. These rocker bearings are built into the crossbeam web except the southeast rocker, which, due to the bridge super-elevation, connects to the bottom flange of the crossbeam. The crossbeams & rocker bearings were re-painted in 1998/1999. The faces exposed to the finger joints have extensive surface pitting with some areas of severe section loss with holes at the base of stiffeners. The rocker bearings are measured & checked for movement during each annual inspection. All four bearings appear to be functioning. They show obvious signs of movement.

In 1986, the southeast rocker bearing "froze", resulting in damage to the crossbeam with two cracked vertical web stiffeners. The rocker-bearing pin was replaced. This required closing I - 35W and jacking up the span. The crossbeam was repaired and the cracks in the web stiffeners were welded, crack ends drilled out, and stiffeners reinforced with angle plates. Installing braces between the crossbeam and beams #2 & 3 also reinforced the connection.

In 1992, a crack was found in a crossbeam stiffener weld above the northeast rocker bearing, which was drilled out. In 1997, at the same location, a weld between a vertical & horizontal stiffener was found cracked through entirely. Cracks were also discovered at the end of horizontal stiffeners near the northeast & southwest rocker bearings. Strain gauges were installed to analyze stresses, crack ends were drilled out, and installing bracing between the crossbeam and 2 stringers reinforced the northeast connection.

Steel Multi-Beam Approach Spans (spans #1 - 5 & #9 - 11): The approach spans have welded beams - the depth transitions from 48" to 33". Connections are riveted. The south span has 33" deep rolled beams with welded cover plates (square ends). Spans #1 - 5 have 14 beams (with a hinge joint in span #2). In spans-#9 - 11, the deck widens from 15 to 18 beams. The fascia beams have minor section loss, with moderate flaking rust along the bottom flange - the beams adjacent to the median were re-painted in 1999.

In 1998, fatigue cracks were found in several beam webs. These cracks were located in negative moment regions at the top of the diaphragm connections. At one location the web had cracked through entirely and was caused by out of plane bending in locations where the web stiffener was not rigidly connected to the top flange. After stain gauge analysis by the University of Minnesota, the diaphragm connections were modified. They were lowered, using only four bolts at each connection. Most existing cracks were drilled out. Some were too small to reach, and the fractured beam was reinforced with bolted plates.

In span #2, multi-beam approach span, there is a cantilever expansion hinge with sliding plate bearings. The joint is closed beyond tolerable limits, possibly due to substructure movement & pavement thrust and is no longer functioning. Some beam-ends are contacting, and some bearing plates have tipped, preventing the joint from reopening. The hinge area, with open finger joint above, was re-painted in 1999. The beam-ends have section loss, moderate surface pitting.

The north approach spans have lateral & diagonal bracing welded to the web.

Approach Span Bearings: The steel beam approach spans have a total of 90 sliding plate bearing assemblies and 33 fixed plate bearing assemblies. The piers with fixed bearings have expansion bearings on the fascias.

Voided Concrete Slab North Approach Spans (Spans #12 – 14): The far north approach spans consist of cast-in-place concrete continuous "voided" slabs. They are 2 ft deep. Northbound off ramp splits off to form Bridge #9340A. The slab rests on sliding plate bearings at pier #11 and the north abutment. There are 29 bearing assemblies. Piers #12 & #13 are cast directly into the slab with no bearings. These spans are in generally good condition. Spalling along the exterior and median copings was patched with shotcrete in 1998. [2001] Light fixtures at Metal Matic Incorporated parking lot.

BRIDGE SUBSTRUCTURE: NBI CONDITION CODE 6

Abutments: The abutments have vertical cracking, with some staining from leaking deck joints.

Truss Span Piers: Piers #6 & 7, main river span, have two concrete columns resting on a pier wall. The west column on pier #7 has a minor vertical crack. Piers #5 & 8 have two concrete columns connected with an upper strut. The column on pier #8 has been reinforced with a concrete "jacket". [2001] Underwater inspection conducted by Collins Engineers, Inc. in 2000 found pier 7 to be in good condition with no defects of structural significance. A 3 x 3 foot area of light scaling, with a maximum of 1" of penetration was observed on the south side of the upstream pier nose. Collins recommends inspecting the substructure unit at the normal 5 year inspection interval. [2004] The concrete surfaces below the water are in good condition. Minor scaling was found above the, but not of the quantity or depth as noted in the previous report the total area was 2 feet square and ¼" deep penetration. No significant changes in the structure or channel condition since last inspection by Ayres Associates.

Approach Span Piers: Piers #1 - 5 & #9 - 11, piers supporting the steel spans, consist of concrete columns with a cap. Those adjacent to railroad tracks have lower struts. The pier columns supporting the voided slab spans (piers #12 & 13) are cast directly into the slab with no cap. Pier #1 has tipped slightly to the north. This is related to the hinge failure in span #2. The east column on pier #9 has minor scrapes & spalls from a train derailment in 1969. Pier #11 has extensive shotcrete repairs from leaking deck joint above.

OTHER BRIDGE ELEMENTS

Approach Panels: All approach panels are concrete. Each approach panel has a transverse crack, and there are some minor spalls at the joints. The relief joints need to be resealed. North approach, SBL and on ramp, has no relief joint. [2001] South approach panel was scarified and a low slump overlay was installed.

Channel & Protection: NBI code #8 which is very good condition. The bridge is located just downstream from the Lower St. Anthony Lock & falls - the flow is very turbulent. At normal river level, clearance below the truss is approximately 60 feet. Pier #7 is the only pier in the channel, along the east bank. Typically, the water depth along the west face is only 1 - 2 feet. Mn/Dot does not conduct underwater inspections. Due to the extreme turbulence, sonar readings of the channel cross-section cannot be taken.

Signing: There is an overhead sign bridge structure running across the entire deck, mounted on the exterior railings at truss panel point #2' at north end of truss. There is a signpost mounted on the west railing at truss panel point #6 at south end of truss.

Guardrail: In 1998, the approach guardrails were repaired. Impact attenuator was installed at the northbound off ramp to University Avenue. Both approach medians of I-35W & the SE, SW corners have plate beam guardrail.

Drainage: Several deck drains drop directly into the river. The drain troughs at pier #6 have inadequate slope, and tend to fill up with debris. In 1998-99, the drain troughs below the arch end finger joints were removed, and replaced with rubber "skirts". The skirt sections above the truss end rockers tend to fill with debris. These should be flushed annually.

Slope Protection: The concrete slope paving, at both abutments, is in good condition.

Lighting: Rail mounted deck lighting, under deck lighting in span #13, and river navigation lighting. "Metal-Matic Inc." maintains the lighting above the parking lots in spans #11 & 12. A light post, W 5/3 L, on the west railing, has a 6" vertical split from plow damage.

Miscellaneous: The former "U of M" parking lot area below spans #2 - 5 has been barricaded from use while the parking lot area below spans #11 & 12 continues to be used by Metal Matic Inc employees. The U.S. Army Corps of Engineers is stockpiling river debris material below span #8 this material is approximately 10 to 15 feet below the bottom truss diagonals (2003). The navigation light maintenance catwalk, which is below the median of the truss spans, is being accessed by graffiti "artists" at pier #5.

De-icing System: In 1999, an automated de-icing system was installed on the deck, with spray nozzles installed in the deck and railings and a pump house/control room was constructed at the NW approach corner.

BRIDGE SNOOPER FIELD INVESTIGATION

Northbound & southbound inspection notes are combined. Plans have beams numbered from the east. Exterior of west rail, east & west coping have conduit full length of bridge.

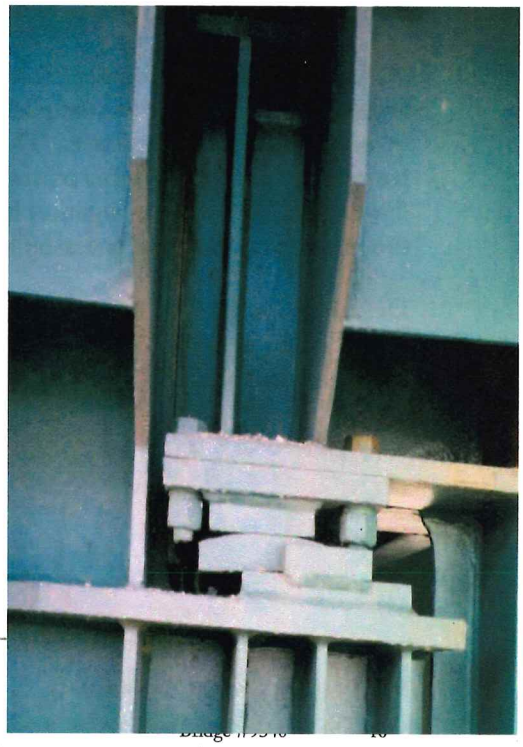
South Abutment:
Type H: strip seal deck joint above. [1995] Bearings are corroded and in full contraction from hinge failure in span #2, and tipping of pier #1. The seat area is cracked and discolored. [1998] SBL Gland was patched using an experimental joint, hot poured seal with wire mesh reinforcement, and fourteen sliding plate bearing assemblies. [2003] South abutment has 72 LF of random cracks.

Span #1 (Steel Multi-beam):
Span is 53 FT long with 14 beams, 33" deep rolled beams, with welded cover plates with square ends. [1978] 3 West bays have 300 SF full depth deck patches. [1998] "Stool" concrete is spalling off adjacent to median beams. [1999] Beams 6, 7, 8, & 9 were re-painted. [2003] Surface rust: on the beams. [96/2005] East fascia beam has section loss, flaking & surface rust on bottom flange.

Pier #1:
10 Fixed; & 4 sliding plate bearing assemblies. Pier consists of 4 concrete columns and cap, with a railroad crash strut between the columns. [1996] Pier has tipped slightly to the north (measured with plumb bob). [1999] Bearings 6, 7, 8, &. 9 were re-painted.

Span #2 (Steel Multi-beam):
Span is 72 FT long with 14 beams; 33" rolled beams with welded cover plates, some with square end welded cover plates, the beams transition to 48" welded beams north of the hinge joint. [1978] 350 SF: full depth deck repairs. [1997] Conduit is loose below median. [1998] "Stool" concrete is spalling off adjacent to median beams. [1999] Beams 6, 7, 8, & 9 were re-painted. [96/2003] Bottom flange at girder transitions & at hinge has section loss, flaking rust. [2005] East fascia beam has section loss, flaking & surface rust on bottom flange. Beam #11 has peeling paint on the bottom flange.

Hinge Joint (12 ft. South of Pier #2):
Hinge joint has open finger joint above. [1999] Hinge area re-painted. [2000] Beam-ends have section loss, moderate surface pitting; debris has begun to build up on hinge area. Additionally, the tops of the beam ends are contacting at the top flange or at the web along this joint. [94/2005] All hinge assemblies are expanded beyond tolerance; sliding plates extend 4" or more beyond the base plates, reducing bearing capacity. At beam #10, the sliding plate has tipped, falling off the base plate, and is preventing the joint from opening. [2005] Hinges should be flushed.



Sliding Plate @ West Fascia

Sliding Plate @ Beam 5 NBL

Sliding Plate @ Beam 6 NBL

Pier #2:
Pier consists of four concrete columns, 14 sliding plate bearing assemblies, and cap, with a railroad crash strut between the columns. [97/2000] Bearings have surface rust corrosion; east end of cap has 6 SF of delamination. [1999] Bearings 6, 7, 8, &. 9 re-painted. [2003] East end of cap, on south face has 2 SF of delamination, & 10 SF of map cracking.

Span #3 (Steel Multi-beam):
Over Bluff St. Span is 110 FT long with fourteen, 48" deep welded plate beams. [1978] The 3 west bays have some full depth deck patches. [1997] Second bay from east has 20 SF of leaching map cracks. [1998] "Stool" concrete: spalling off adjacent to median beams. [1999] Beams 6, 7, 8, & 9 re-painted. Diaphragm line: north of pier #2, diaphragms were lowered, although the connections have a "positive moment" configuration stiffeners welded to the top flange, no cracks. Refer to Appendix "A" **First Diaphragm South of Pier #3** graph for crack locations, description & repair to the diaphragm line. [2005] East & west fascia beam has section loss, flaking & surface rust on bottom flange.

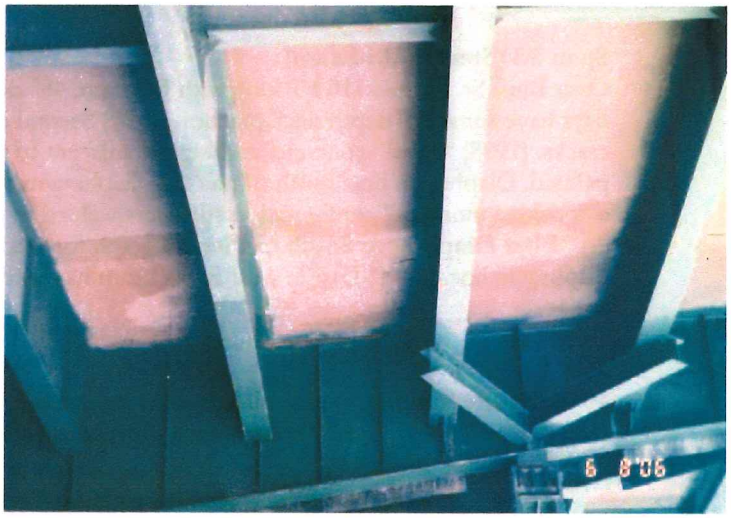
Pier #3:
10 fixed plate, and four sliding plate bearing assemblies. Pier has four concrete columns and a cap. [1999] Bearings 6, 7, 8, &. 9 were re-painted. Vertical stiffener working: at girder 11.

Span #4 (Steel Multi-beam):
Over contract parking lot (no access) & Bluff St. Span is 110 FT long with fourteen 48" deep welded plate beams. [1978] Second & third bays from the east have full depth deck repairs. [1998] Underside of deck has 200 LF of transverse leaching cracks, 200 SF of spall with exposed rebar below a transverse poured joint, full width of deck. [1999] Beams 6, 7, 8, & 9 were re-painted. Diaphragms lowered, even though the connections have a "positive moment" configuration. Stiffeners are welded to the top flange. Refer to Appendix "A" **First Diaphragm North of Pier #3** graph for crack locations, description & repair to the diaphragm line. [1998/99] Diaphragms lowered with strain gauges placed on beams #2 & 6 ***(first diaphragm Line South of Pier #4).*** [2000] Fourth bay from west has 20 SF of severe leaching. [2005] East fascia beam has section loss, flaking & surface rust on bottom flange.

Water Saturation SBL Bays 9 & 10

Pier #4:
14 Sliding plate expansion bearing assemblies. [1997] Bearings have surface rust. Pier consists of 4 concrete columns and cap. [1999] Bearings 6, 7, 8, &. 9 were re-painted.

Span #5 (Multi-beam/Deck Truss):
Over contract parking lot; span is 109 FT long with fourteen, 48" deep welded plate beams bolted onto the crossbeam. [1978] Underside of deck is leaching at the finger joint, has two full depth patches in the west bays. [1996] 4 conduit clamps missing on NB fascia beam. Median girder has impact damage from parking lot below. [1998] Bay just east of median has severe spalling on "stool" and the adjacent deck is cracked. [1999] Beams 6, 7, 8, & 9 were re-painted. Refer to Appendix "A" **First Diaphragm North of Pier #4** graph for crack locations, description & repair to the diaphragm line.



Water Saturation NBL Bays 2, 3 & 4

Multi-beam Spans Looking South

MAIN TRUSS (EAST TRUSS)

Crossbeam:
[1986] The SE rocker bearing froze, damaging the east end of the crossbeam, resulting in cracked web stiffeners. The bridge was jacked up. I-35W was closed to traffic. SE rocker pin was replaced, cracks in two stiffeners were welded and drilled out, and bracing was added between the crossbeam and beams #3 & 4. [1998/99] Crossbeam was repainted; the side facing the finger joint has section loss.

CROSSBEAM & FLOORBEAM GAP (EAST END)

Date	Measurement
September, 1998	16-5/8"
April, 1999	17-13/16"
April, 2000	18"
September, 2001	18-1/16"
June, 2003	16-7/8"

Panel Point #0 (Beginning of East Truss):
Expansion joint has open finger joint above. [1998] Drain troughs removed. [1998/99] End floorbeam was repainted; pitting at connection, section loss at the base of the stiffeners. [1999] Rubber "skirts" installed below the finger joint. [2000] Rubber trough above rocker bearings filled with debris; needs to be flushed. [2002] Panel points 0 to 1 there is water saturation between stringers 2 thru 4. [2005] Stringers 2 & 3 have flaking & surface rust.

Deck Truss Looking North

Panel Point #1 (East Truss, Pier #5):
[2005] Bottom of truss diagonal L1U0 has flaking & surface rust.

Pier #5:
Bearing assemblies have two "rollernest". Climbing onto the pier strut at this location accesses the catwalk. Debris piled at pier strut base allow for unauthorized access. [2002] Bearings show signs of recent movement.

Span #6 (Deck Truss):
Span is 266 FT long with seven floorbeam trusses. [1997] West River Parkway constructed below bridge. [1999] Floorbeam truss's, sway bracing located below the median and beams 6, 7, 8, & 9 were re-painted.

Panel Point #2 (East Truss):

Panel Point #3 (East Truss):
Floorbeam truss, near center, has an undercut weld in the flange.

Panel Point #4 (East Truss Stringer Joint):
Type H: strip seal deck joint above. [1996] Floorbeam truss bottom chord/vertical member connection gusset plate has a weld overlap. [1999] Gland has 1 LF of gland pulled out at centerline. Junction box cover is missing at catwalk. [2000] Joint gland at east end has concrete in. [2005] Pitting, flaking & surface rust exterior east truss.

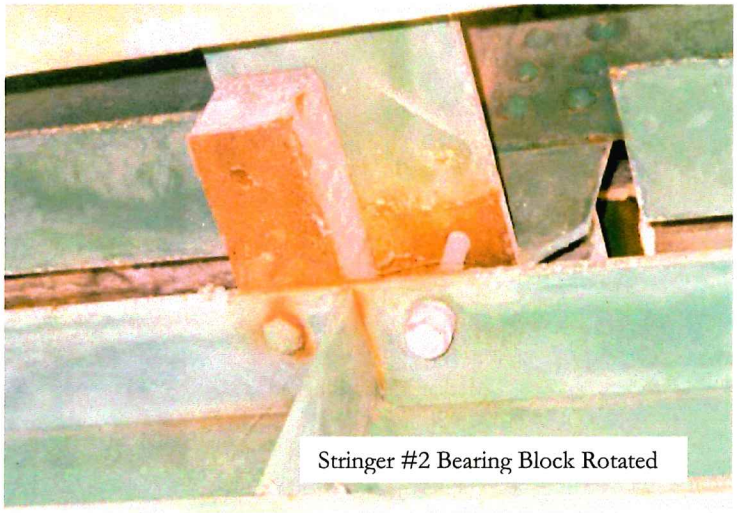
Flaking & Surface Rust Exterior East Truss

Panel Point #5 (East Truss):
[1997] Cracked tack weld between the floorbeam truss top chord and a stringer bearing pedestal. [1999] Tack welds ground out at stringer #3, cracked tack welds remain at stringer #4.

Panel Point #6 (East Truss):
[1994] Floorbeam truss top chord, bottom flange, has a poor quality weld at the end of a connection plate. [1999] Stringer #5 bearing pedestal has a cracked tack weld. [2003] Top chord of the floorbeam truss, just east of east truss, has an old dent on the top flange.

Panel Point #7 (East Truss):
[2003] Top chord of the floorbeam truss, just east of east truss, has an old dent on the top flange.

Panel Point #8 (East Truss Pier #6 Stringer Joint):
Type H: strip seal and deck drain above. [1999] Missing bolt replaced. Vertical truss member has pitting, section loss, moderate flaking rust. Floorbeam bottom chord & middle bracing connection plate has pitting, moderate section loss, severe flaking rust. Middle bracing connection plate has ½" spread from pack rust. Underside of the deck has 50 SF of water saturation. [94/2003] Joint is leaking, small hole & membrane has pulled out. Stringer #4: one bolt broken off at south floorbeam connection. Stringer #2 (south side): bearing block has rotated 90°.


Stringer #2 Bearing Block Rotated


Stringer #4 Bolt Missing


Plugged Horizontal Drain

Median Drain Plugged

Pier #6 (Downtown, West Bank of Mississippi):
Pier consists of two concrete columns with a pier wall at the base, two "rollernest" bearing assemblies. [1997] Bearings have surface rust, moderate corrosion and show no signs of movement. Deck drain downspouts are clogged, top & bottom at median. [2004] Typical condition & rust at floorbeam connection near deck drain at connection L8.

Floorbeam Truss Condition

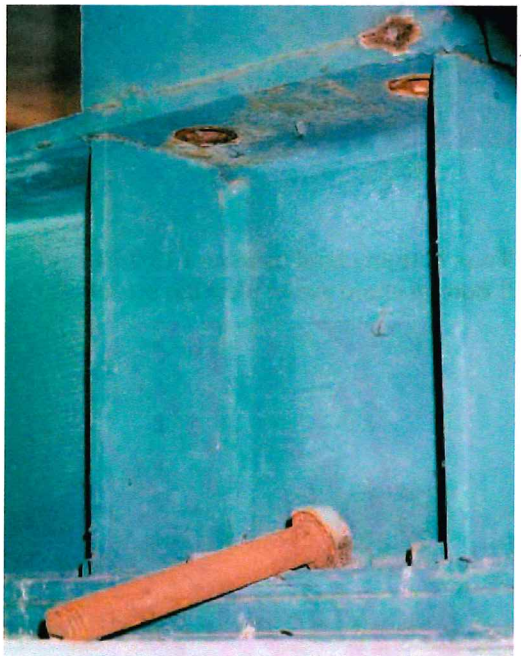
Span #7 (Deck Truss):
Span is 456 FT long with 12 floorbeam trusses. [1999] Floorbeam truss's, sway bracing located below the median and the beams 6, 7, 8, & 9 were re-painted.

Panel Point #9 (East Truss):
[2003] Floorbeam bottom chord connection plate has a cracked tack weld on the south side. Underside of the deck has 20 SF of water saturation.

Panel Point #10 (East Truss):
Red navigation light for Mississippi river channel. [1999] Strain gauges installed on truss top chord member U9/U10, L9/U10 &L9/L10 from U of M research project.

Panel Point #11 (East Truss):
Section loss: at gusset plate bottom chord. [2004] Pitting: inside gusset plate connection at L11 toward L10. [2000/05] Stringer #3 has two bolts missing at the floorbeam connection.

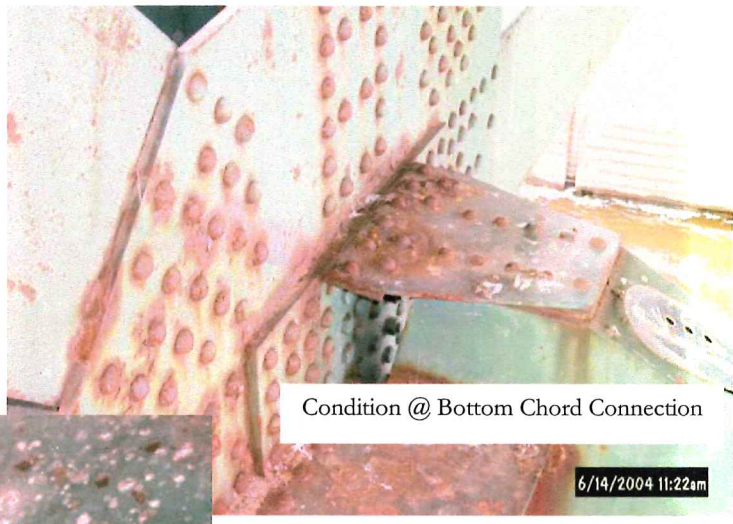

Pitting at L11/L10 Connection


Bolts Missing @ Floorbeam Connection

Panel Point #12 (East Truss):
[1999] Truss bottom chord member L12/L13 has a cracked tack weld at an interior stiffener. [2004] Ground out pit from past inspection.

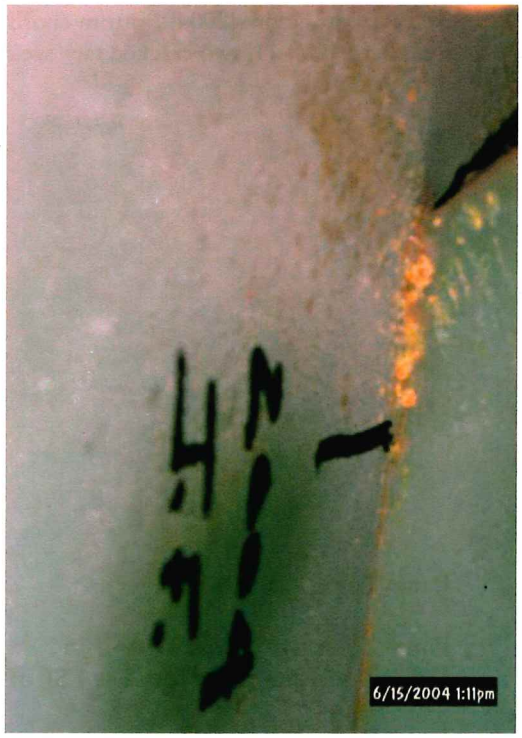

Weld Ground Out

Panel Point #13 (East Truss):
Water from deck drains fall directly into river. [1999] Truss bottom chord member L13/L14 has cracked tack welds at two interior stiffeners. [99/2002] Bottom chord gusset plate has section loss, flaking & pack rust. [2004] Bottom chord member L13/L14 has cracked tack weld at diaphragm tab. Cracked tack weld at diaphragm tab member L13/U14. See photos. [2006] Bottom chord member L13/L14 has a missing bird cover.


Condition @ Bottom Chord Connection
6/14/2004 11:22am


Member L13/U14 Cracked Tack Weld
6/14/2004 10:20am

Panel Point #14 (East Truss Midspan Stringer Joint):
Strip seal expansion joint on the deck. Sway frame rusty. [1999] Truss bottom chord member L14/L13' has a cracked tack weld at an interior stiffener. [2002/03] Floorbeam bottom chord & middle bracing connection plate has ½" pack rust. Underside of the deck has 4 SF of delamination. [2004] Bottom chord member L14/L13' cracked tack weld at diaphragm tab.



Member L14/L13' Cracked Tack Weld

Panel Point #13' (East Truss):
Floorbeam truss top chord has a ground out spot near stringer #4. [1996] Truss bottom chord member L13'/L12' has a cracked tack weld at an interior stiffener. [2003] Truss bottom chord connection plate has ½" pack rust. Underside of the deck has 20 SF of water saturation. [2004] Bottom chord member L13'/L12' has cracked tack weld at diaphragm tab.

Member L13'/L12' Cracked Tack Weld

Panel Point #12' (East Truss):
[1998] Truss bottom chord member L12'/L11' has a cracked tack weld at an interior stiffener. [99/2003] Underside of the deck has 65 SF of water saturation. [2004] Bottom chord member L12'/L11' two cracked tack weld at diaphragm tab.


Member L12'/L11' Cracked Tack Weld

Panel Point #11' (East Truss):

Panel Point #10' (East Truss):
[2003] Underside of the deck has 1 SF of spall with exposed rebar. Light pole, W5L3, has 1 LF crack.

Panel Point #9' (East Truss):
Water from deck drains fall onto the steel & directly into river. [2002] Bottom chord member L9'/L8' has section loss, flaking rust.

Panel Point #8' (East Truss Pier #7 Stringer Joint):
Red navigation light for Mississippi river channel. Type H: strip seal expansion joint on the deck. [93/2003] Floorbeam truss has section loss, moderate flaking rust. North side: bolts replaced with "threaded-rod" at stringer #4, bolts replaced at stringer #5. Underside of the deck has 80 SF of water saturation.
Pier #7 (East Bank of Mississippi):
Two fixed bearing assemblies. Pier consists of two concrete columns with a pier wall at the base. [1997] West column has a full height, leaching crack on the south face.

Span #8 (Deck Truss):
Span is 266 FT long with seven floorbeam trusses. [1999] Floorbeam truss's, sway bracing located below the median and the beams 6, 7, 8, & 9 were re-painted.

Panel Point #7' (East Truss):
[2003] Underside of the deck has 240 SF of water saturation, & 80 SF of delamination.

Panel Point #6' (East Truss):
[1996/98] Stinger #4 connection to the floorbeam truss is "working". The SW bolt is loose. [2003] Underside of the deck has 10 SF of water saturation.

Panel Point #5' (East Truss):
[2001] Underside of the deck has 30 SF of water saturation.

ERROR: ioerror
OFFENDING COMMAND: image

STACK:

-dictionary-
-savelevel-

Panel Point #4' (East Truss Stinger Joint):
Type H: strip seal expansion joint on the deck. Truss diagonal member U4'/L3' has backer bars along the interior edges. [01/04] Strip seal has 3 LF of gland pulled out. Truss connection plates, the top chord, and floorbeam have moderate section loss, severe flaking rust. Bottom connection plates have ½" pack rust.

Top Floorbeam Truss Condition

Top Floorbeam Truss Condition

Bottom Floorbeam Truss Condition

Bottom Floorbeam Truss Condition

Bottom Truss Condition

Panel Point #3' (East Truss):
Center lane has road sensors on the deck surface. Top chord of the floorbeam truss has an "incomplete" weld along the top edge of the web reinforcement plate.

Panel Point #2' (East Truss):
Overhead sign mounted on exterior railings. [1999] Deck in bay #3 has 100 SF of water saturation. [2003] Bottom connection plates have flaking rust. [2004] Area underneath overhead sign has 100 SF of water saturation. [2005] North support beam stringer has severe section loss at end.

North Support Beam Stringer

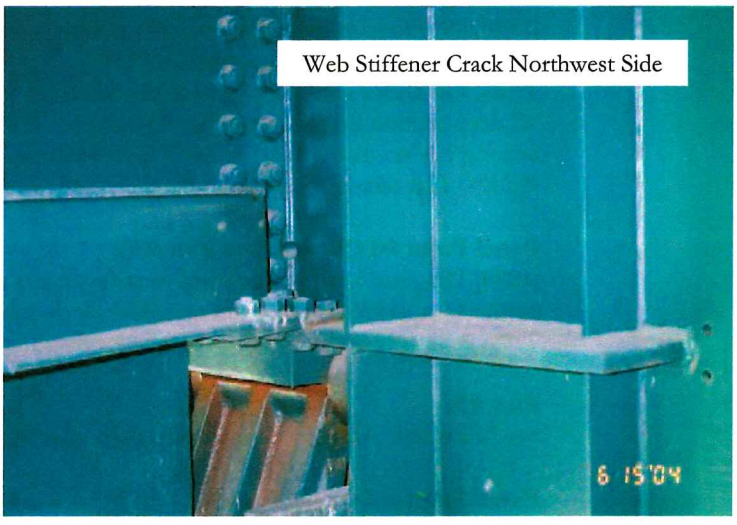
Pier #8:
Two "rollernest" bearing assemblies, have surface rust. [2000/05] East truss rocker shows recent movement. Pier consists of two concrete columns connected by an upper strut. Columns have concrete "jackets" around them with vertical cracks.

Panel Point #1' (East Truss Pier #8):
[2000] Bottom of truss above bearing has graffiti. [2005] Bottom of deck deteriorated.

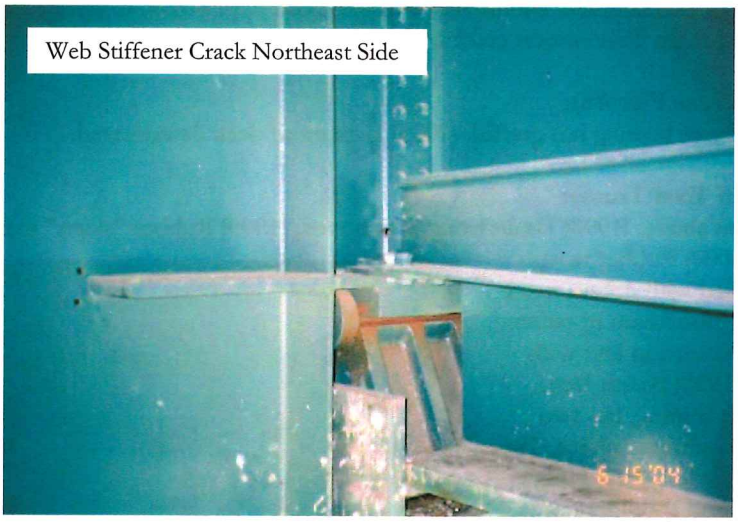
Panel Point #0' (End of East Truss):
Joint has open finger joint above. [1998] Drain troughs removed. [1999] Rubber "skirts" installed below the finger joint. [2000] Rubber trough above rocker bearings filled with debris, need to be flushed. [1998/99] Floorbeam re-painted, side facing finger joint has section loss with holes in web stiffeners. [1998] North face, directly above east rocker bearing, has two horizontal welds between stiffener plates. They have cracked through entirely. [2004] Finger joint in the SB right lane and shoulder has been ground down to prevent the snow plows catching on the joint.

Deck Truss Looking South

Crossbeam:
[1992] North face has crack in the crossbeam web stiffener, above the rocker at the beam #12 connection. This was drilled out. [1997/98] North face: weld above east rocker bearing, between the horizontal & center vertical stiffener, has cracked through entirely. Weld end at the crossbeam web was partially drilled out. [1998] North face has cracks at both ends of the horizontal stiffener, above rocker bearing. They were drilled out with two small holes drilled in crossbeam web at each location. Bracing installed between crossbeam, above east rocker, and beams #3 & 5. [1998/99] Crossbeam re-painted. Side facing finger joint has section loss, with pitting at base of stiffeners. [1999] Bolted connection between beam #12 and the crossbeam was re-tensioned. Connection had been "working" ** *[2000] Gap between crossbeam & floorbeam (at rocker bearing) was 3-⅛" at 40° F. [2001003] Gap between crossbeam & floorbeam (at rocker bearing) was 3-½".* [2005] Movement at east bearing.



Web Stiffener Crack Northwest Side



MAIN TRUSS SPAN (WEST TRUSS)

Panel Point #0 (End Floorbeam End of West Truss):
Open finger joint on the deck. [1998] Drain troughs removed. [1999] Rubber "skirts" installed below the finger joint. [2000] Rubber trough above rocker bearings: filled with debris, needs to be flushed. [1997] Floorbeam horizontal stiffener is bent directly above the rocker bearing. [1998/99] Floorbeam re-painted, side facing finger joint has section loss, pitting. [2004] Truss, top chord exterior connection plate has ⅛" deep section loss with pitting. SW rocker bearing has no movement. **[2000] Gap between crossbeam & floorbeam, at west end, measures 16-½".* **[2004] Gap between crossbeam & floorbeam, at west end, measures 14-½".*

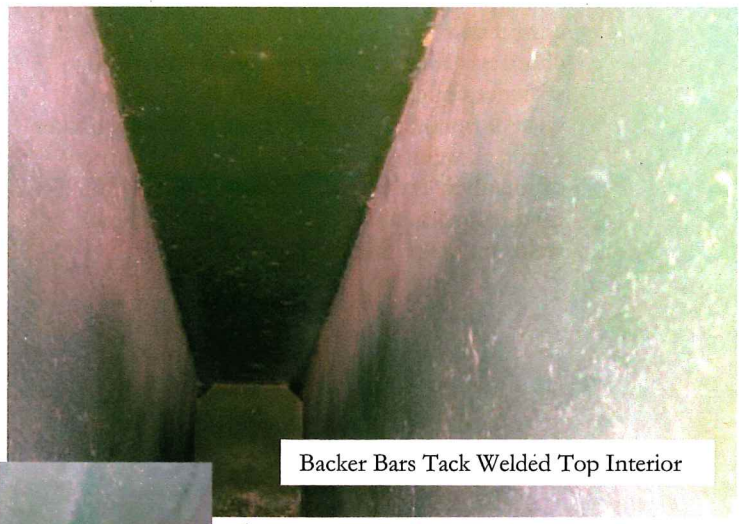
Gap between Crossbeam & Floorbeam (East End)	
Date	**Measurement**
September, 1998	16-⅝"
April, 1999	17-13/16"
April, 2000	18"
September, 2001	18-1/16"
June, 2003	16-⅞"

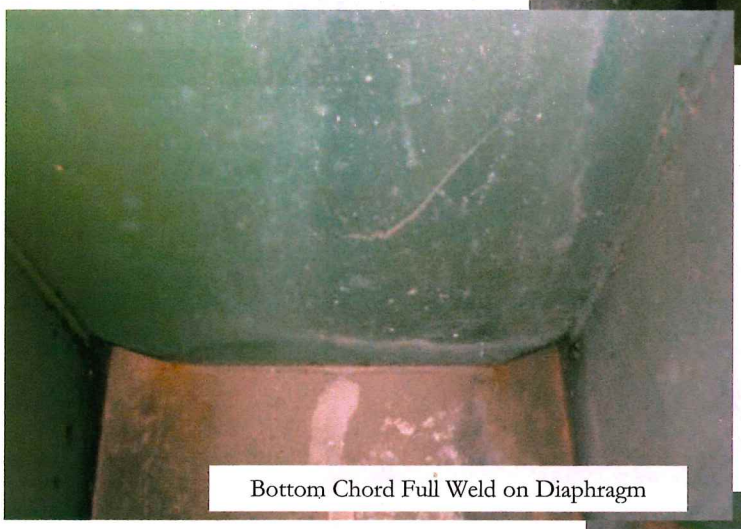
Panel Point #1 (West Truss Pier #5):
[1994] Diagonal brace, floorbeam to stringer, has a cotter pin missing at the floorbeam truss connection. [1998] Deck drain detached from downspout, originally drained into storm sewer. [2004] Truss & floorbeam top chords & interior diaphragms have flaking rust.

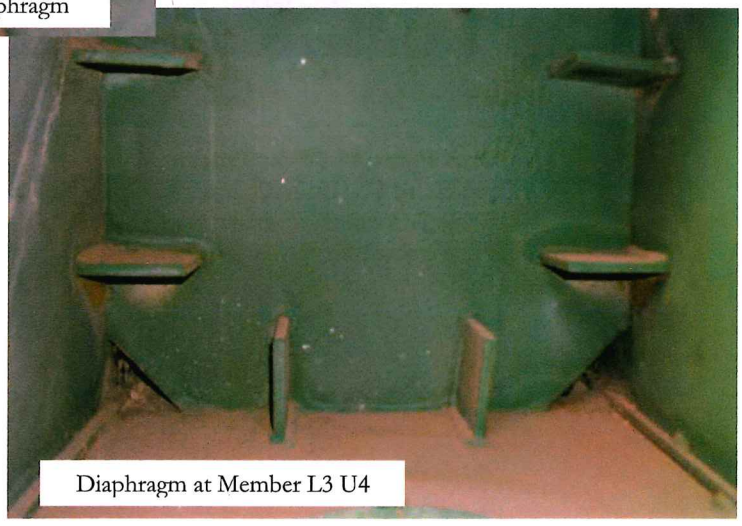
Pier #5:
See NB notes. Access ladder to catwalk removed.

Panel Point #2 (West Truss):
[1996] Floorbeam truss member L2/U3 has a welding flaw. [1997] No crack! Magnetic particle tested. [2004] Truss & floorbeam top chords & interior diaphragms have flaking rust.

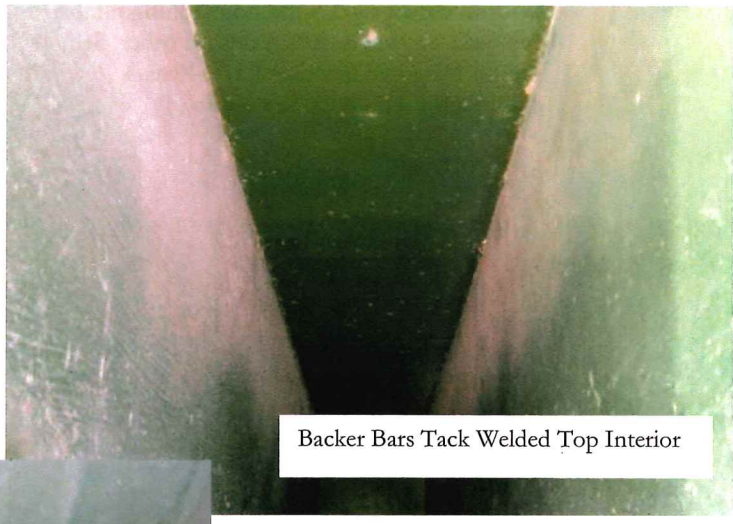
Panel Point #3 (West Truss):
[2004] Truss bottom chord L2/L3 has a nick. Top chord U3/U4 has backer bars tack welded along the top interior corners of member. See photo. Bottom chord L4/L5 has no diaphragm tabs, full weld on side & tack welds on other. See photo. Diagonal member L3/U4 has 4 diaphragms with tabs. See photo.

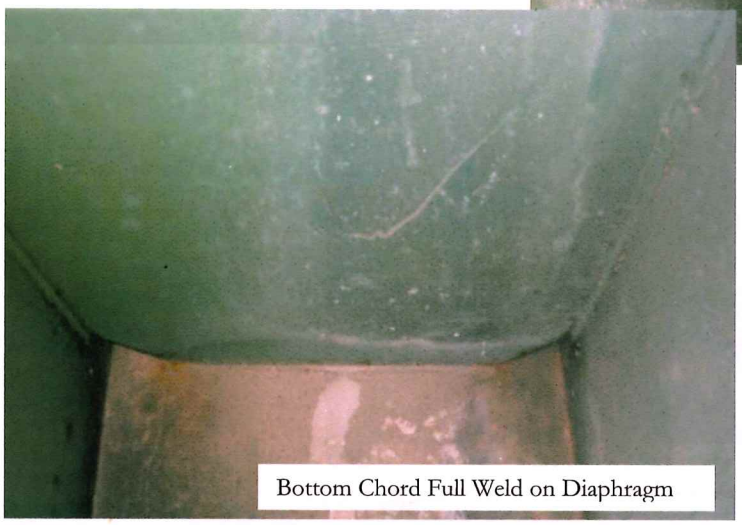

Backer Bars Tack Welded Top Interior


Bottom Chord Full Weld on Diaphragm

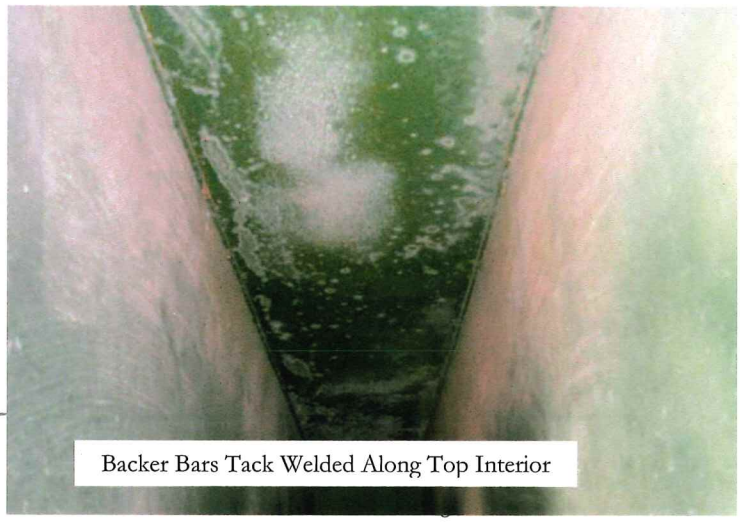

Diaphragm at Member L3 U4

Panel Point #4 (West Truss Stringer Joint):
Strip seal expansion joint on the deck, [1998] Stringer #10: bolt replaced at south floorbeam, truss connection. [2000] Lighting conduit is held up with tie wire. [2004] Stringer #11 floorbeam connection has moderate flaking rust. Truss top chord has flaking rust. Floorbeam top chord, stiffener under stringer #10 has cracked tack weld & is working. Top chord U4/U5 has backer bars tack welded along the top interior corners of member. See photo. Bottom chord L4/L5 has no diaphragm tabs, full weld on side and tack welds on other. See photo.


Backer Bars Tack Welded Top Interior


Bottom Chord Full Weld on Diaphragm

Panel Point #5 (West Truss):
Top chord U5/U6 has backer bars tack welded along the top interior corners of member. [2004] Truss bottom chord, bottom lateral connection plates have spread 3/16" from pack rust.


Backer Bars Tack Welded Along Top Interior

Panel Point #6 (West Truss):
Overhead sign mounted on railing. Floorbeam truss top chord (U5/U4) has gouges in the bottom flange at the end of the connection plate; the bottom chord of the floorbeam truss has 3 spots ground out. Floorbeam truss top chord is offset vertically ¼" at the splice from construction.

Panel Point #7 (West Truss):
[2002] Underside of the deck has 20 SF of water saturation at stringer 12 thru 14.

Span #6:
Span is 266 FT long with seven floorbeam trusses.

Pier #6:
See NB notes.

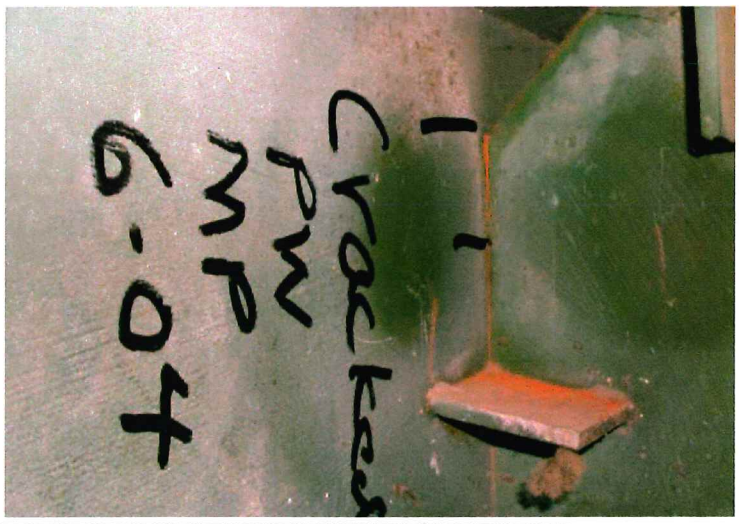
Panel Point #8 (West Truss Pier #6 Stringer Joint):
Type H: strip seal expansion joint on the deck. Deck drains. [96/2003] Drain clogged at median, horizontal trough, standing water in east grate. [96/2005] Strip seal gland has 12 LF pulled out in right gutter line. [2004/05] Vertical member L8/U8, bottom chord, & floorbeam connection plates have moderate flaking & surface rust from plugged deck drain. [2005] Stringers #10 & #11 have flaking rust on the north side.

Panel Point #9 (West Truss):
Truss diagonal L9/U8 has a spot ground out.

Panel Point #10 (West Truss):
Truss top chord U10/U9 has two spots ground out. [2005] Vertical ladder to access cat walk. Stringer #8 has some loose stool concrete.

Panel Point #11 (West Truss):
[1998] Stringer #11 has three bolts replaced at the floorbeam truss connection; the SE bolt is too short with inadequate threads. Stringer has lifted 3/32" off the bearing block on the south side. Stringer #3 has tack welds ground out.

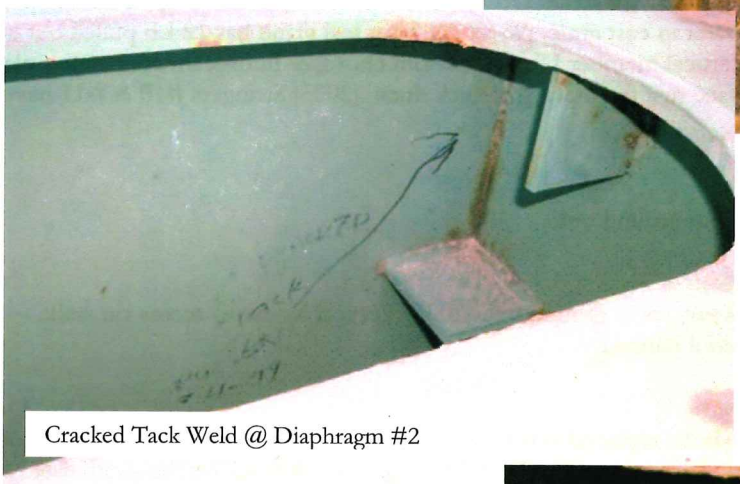
Panel Point #12 (West Truss):
[1996] Bottom chord member L12/L13 has a cracked tack weld at the internal stiffener. [2004] Bottom chord member L12/L13 has a cracked tack weld (diaphragm #2), (not at diaphragm tab). See photo.



Cracked Tack Weld @ Diaphragm #2

Panel Point #13 (West Truss):
[1996/99] Bottom chord member L13/L14 has cracked tack welds at two internal stiffeners [1999] Truss bottom chord/sway frame connection plates have ¾" pack rust. [2004] Diagonal L13/U14 has corrosion from deck drain. Cracked tack weld (not at diaphragm tab). Cracked tack weld: (diaphragm #3), (not at diaphragm tab), (entire tack weld broken cleanly).

L13/U14 Corrosion @ Diaphragm



Cracked Tack Weld @ Diaphragm #2

Cracked Tack Weld @ Diaphragm #2

Cracked Tack Weld @ Diaphragm #3

Cracked Tack Weld @ Diaphragm #3

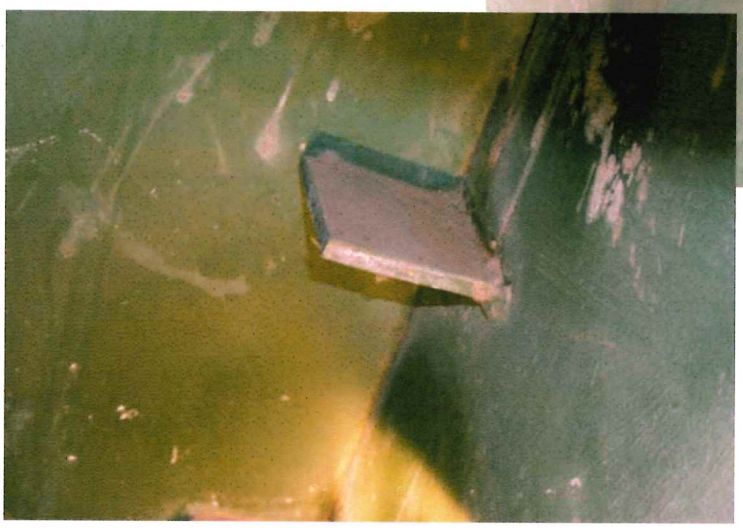
Panel Point #14 (West Truss Midspan Stringer Joint):
Type H: strip seal deck joint above. Deck drains on both sides. [1994] Stringer #11 has section loss, flaking rust near the joint from gland pulled out above. Tack welds along the sway frame/truss, bottom chord, and gusset plate. [1999] Bottom chord member L14/L13' has a cracked tack weld at an interior stiffener. [2003] Stringer #14 connection, south side of the floorbeam, has a cracked tack weld. [2004] Bottom chord member L14/L13' has internal tack welds (full length) at interior diaphragm. Upper chord member U14/U13' has corrosion from deck drain. See photo. [2005] Strip seal gland has 10 LF pulled out. [2006] Reversible diagonal member U14/L13 has section loss with severe flaking rust.

Flaking Rust at Stringer #11

Member L14/L13 Corrosion

Panel Point #13' (West Truss):
[2004] Upper chord member U13'/U12' (diaphragm #2) has no tabs, diaphragm is welded (full length) one side only. Bottom chord member L13'/L12': cracked tack weld (diaphragm #1), (not at diaphragm tab), (clean break). See photo #2.

Full Length Weld @ Diaphragm #2



Cracked Tack Weld @ Diaphragm #1

Panel Point #12' (West Truss):
Truss diagonal member U12'/L13' has 3 "nicks". The truss bottom chord L12'/L13' has a nick.

Panel Point #11' (West Truss):
Nick in the truss bottom chord L11'/L12'

Panel Point #10' (West Truss):
[1994] Stringer #13: loose bolt at floorbeam truss connection. Top chord (U10'/U11') has 6 nicks on the exterior, 15 ft. south of U10'. [2005] Pitting bottom sway frame, 1" diameter holes intermediate & horizontal bracing.

Panel Point #9' (West Truss):
[2001] Truss bottom chord/sway frame connection (gusset plates) has section loss, pitting, heavy flaking rust.

Span #7 (Deck Truss):
Span is 456 FT long with 12 floorbeam trusses.

Pier #7:
See NB notes. [2002] West column has vertical leaching cracks.

Panel Point #8' (West Truss Pier #7 Stringer Joint):
Type H: strip seal deck joint above. [1996] Below stringer #13, the diagonal brace between top and bottom chord of the floorbeam truss is bent, from original construction. [1998] Stringer #11: bolt replaced at floorbeam truss connection. [2001] Truss bottom chord/sway frame connection (gusset plates) has section loss with heavy flaking rust. [2002] Truss bottom chord, L8'/L9', has section loss with heavy flaking rust. [2004/05] Sway bracing center horizontal has 3" x 8" severe pitting & ½" diameter hole; bottom sway bracing has a 2" x 3" hole between stringer #11 & stringer #10. See photos. [2005] Strip seal gland has 5 LF pulled out & is leaking onto the crossbeam below, between stringer 10 & 11.

Pitting @ Center Sway Bracing

Hole in Bottom Member of Sway Bracing

Panel Point #7' (West Truss):
[1997] Top chord/floorbeam truss connection has a cracked tack weld on the diaphragm. [1999] Wind bracing gusset plate, at stringer #14 has loose bolts. [2002] Stringer #14 was installed crooked.

Panel Point #6' (West Truss):
[96/98] Stringer #11, one bolt replaced in 1998 at the floorbeam connection. [1997] Stringer #10, the two south bolts are loose at the floorbeam connection. [99/2003] Stringer #9, south face, has one bolt loose at the floorbeam connection. [2004] Stringer #11 has one loose bolt south side. [2006] Vertical truss tension member L6'/U6': flanges show out of plan bending.

Panel Point #5' (West Truss):
[2002] Sprayer fitting corroded.

Panel Point #4' (West Truss Stringer Joint):
Type H: strip seal deck joint above. Truss diagonal member U4'/L3' has backer bars along interior edges. [1999] Two cracked tack welds at elevation block underneath Stinger #11. [2003] Floorbeam truss bottom chord at Stringer #11 connection: have section loss, pitting, moderate flaking and surface rust.

Panel Point #3' (West Truss):
The floorbeam truss, top flange of upper chord, has an ugly weld below the connection to stringer #11. [2003] Stringer #12 has connection bolts "working".

Panel Point #2' (West Truss):
Overhead sign on bridge, mounted on exterior railings. [2002] Bolts are "working" at stringer #11.

Span #8 (Deck Truss):
Span is 266 FT long with seven floorbeam trusses. [2002] Underside of the deck has 150 SF of water saturation and numerous full depth repairs.

Pier #8:
See NB notes. [1999] West truss bearing shows signs of recent movement.

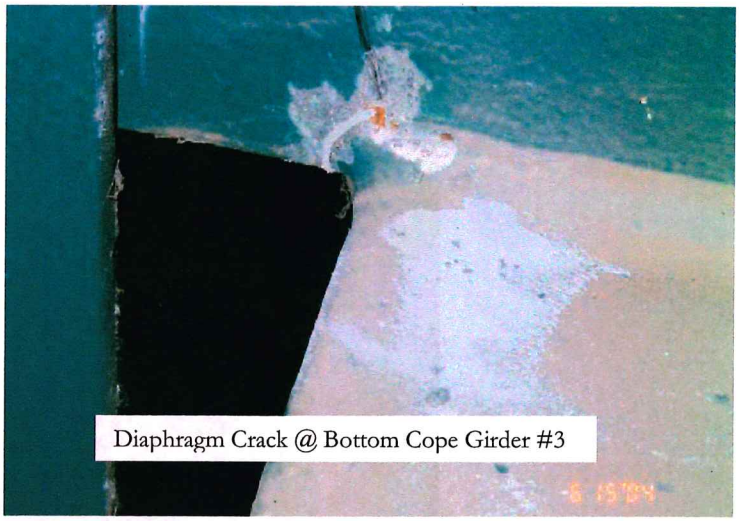
Panel Point #1' (West Truss Pier #8):

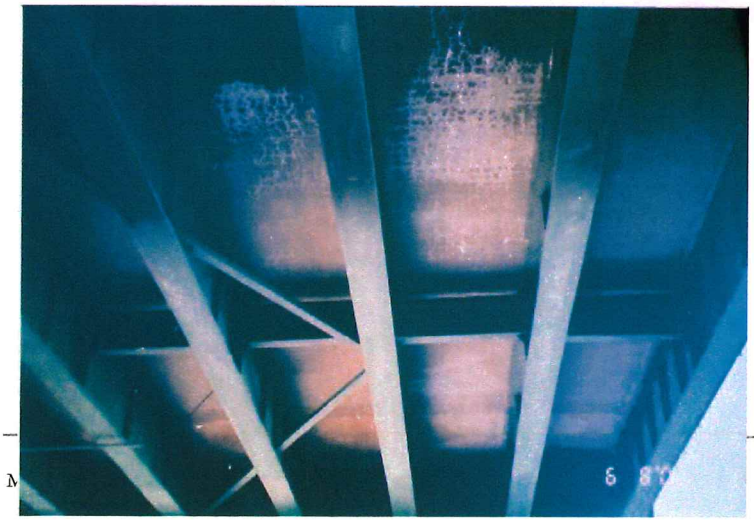
Panel Point #0' (End Floorbeam Beginning West of Truss):
Open finger joint on the deck. [1996] Floorbeam/truss connection has section loss, severe corrosion with surface pitting on plates & bolts. [1997] Conduit running along catwalk is hanging loose, and has pulled out at the floorbeam. [1998] Drain troughs removed. [1998/99] Floorbeam re-painted. Side facing finger joint has section loss on stiffeners. [1999] Rubber "skirts" installed below the finger joint. [2000] Rubber trough above rocker bearings filled with debris; needs to be flushed. [2002] High spots of fingers torched off right lane & shoulder.

Crossbeam:
[1998/99] Crossbeam re-painted. Side facing finger joint has section loss. [1999] Bolted connection between beam #12 and the crossbeam was re-tensioned. Connection had been "working". *[2000] Gap between crossbeam & floorbeam, at rocker bearing, measured at 3-9/16".[2001/03] Gap between crossbeam & floorbeam, at rocker bearing, measured at 3-½".*

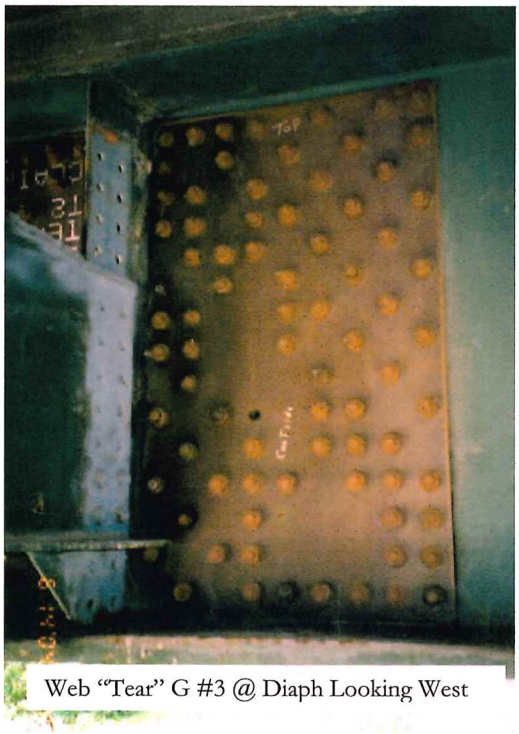
Span #9 (Multi-beam):
Span is 168 FT long with one floorbeam truss at pier #8, fifteen 48" deep welded plate girders bolted onto the crossbeam. Multi-beam spans resume. NB has 8 girders. SB has 7 girders. There are two active railroad tracks below. [1999] Refer to Appendix "A" **First Diaphragm South of Pier #9** graph for crack locations, description & repair to the diaphragm line. Girders 6, 7, 8, 9, & 10 are re-painted. Lateral bracing welded to web & stiffener. [2003] Bottom of deck has conduit on the east side. [2004] Girder 1C (NBL), crack at the diaphragm bottom cope, NE side measures 2" ("front face") and NW side measures 2-½"("Back face"). Girder 3 (NBL), crack at the diaphragm bottom cutout, measures 1-½" (both sides). [1998/2004] Girder #3 has a "tear" in the girder's web at the diaphragm girder connection. The "tear" measured 42" long on one side and 12" long on the other, was caused by out of plane bending between the diaphragm and the girder. Girder Connection Lowered & Girder Web Repaired with Splice Plate. [2002/06] Underside of deck has 260 SF of water saturation, & 4 SF of delamination. [2006] Girder #12 has paint failure from leaking de-icing system.


Diaphragm Crack @ Bottom Cope Girder #1C

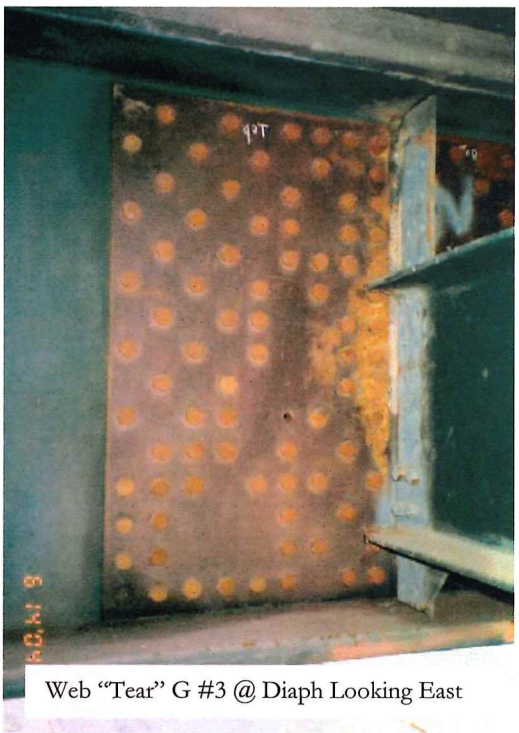

Diaphragm Crack @ Bottom Cope Girder #3


Water Saturation SB Bays 12, 13 & 14

Water Saturation NB Bays 3 & 4



Web "Tear" G #3 @ Diaph Looking West



Web "Tear" G #3 @ Diaph Looking East

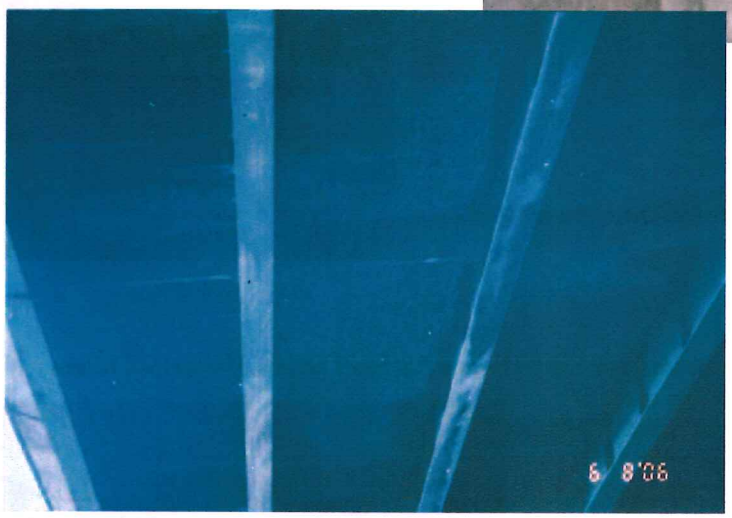
Pier #9:
Plate bearing assemblies have 13 fixed, and four sliding. Pier consists of four columns and cap, with a railroad crash strut between the columns. 2 Deck drain: downspouts. [1969] East column damaged by train derailment: the column has minor scrapes and spalls, downspout had to be reconnected. [1999] Bearings 9, 10, 11, &. 12 were re-painted. [2004/05] West vertical & median deck drain plugged.

Median Drain Plugged Pier 9

Span #10 (Steel Multi-beam):
Span is 94 FT long with 17 steel beams. NB has 10 beams; SB has 7 beams (the welded beams transition from 48" to 33" depth just north of pier #9) with active railroad tracks below. One track splits into two. Refer to Appendix "A" **First Diaphragm North of Pier #9** graph for crack locations, description & repair to the diaphragm line. [1999] Beams 9, 10, 11, & 12 were re-painted. Diaphragms were inverted & lowered, even though the beam connections have a "positive moment" configuration. Connections welded to top flange. [2003] Conduit: at east side bottom of deck. [2000] Beam #6 appears to be "working" at the top connection. [2004/06] Underside of the deck has 550 LF of transverse leaching cracks, 500 SF of water saturation, & 8 SF of delamination.

Girder #10 Vertical Stiffener/Girder Web

Girder #10 Vertical Stiffener/Girder Web



Water Saturation SB Bays 12, 13 & 14

Water Saturation NB Bays 5, 6 & 7

Pier #10:
Pier has 5 columns & cap with a railroad crash strut between the columns and 18 sliding plate expansion bearings. [1999] Bearings 9, 10, 11, & 12 were re-painted. [2003] North face of cap has 20 SF of delamination.

Span #11 (Steel Multi-beam):
Span is 68 ft. long with 18 steel beams. Northbound has 11 beams; southbound has 7 beams, and the parking lot below. [1999] Beams 9, 10, 11, & 12 were re-painted. Connections welded to top flange. Diaphragms were inverted & lowered, even though the beam connections have "positive moment" configuration. [2003] Conduit: east side bottom of deck. [2004] 50 SF of water saturated deck underneath.

Water Saturation SB bays 15 & 16

Pier #11:
Beginning: NB off ramp to University Avenue. (Br. #9340A starts here). Type H: strip seal deck joint above. The pier consists of seven columns & cap and 18 sliding plate expansion bearings. [1998] Extensive shotcrete repairs on pier cap, water stained. [1999] Sliding plate bearings for the steel beams were re-painted. [95/2000] Gland is leaking in several locations (NB & SB). [2000] West column has 1 SF spall. [2004] Cover plate is missing from "J" barrier east rail NBL. [2006] Strip seal is closed to ¾". Shotcrete repair is map cracking. All bearings have moderate corrosion. 3 Under deck lights north face cap.

Span #12 (Concrete Voided Slab Span):
The slab span consists of 15 sliding plate bearings (voided slab). Parking lot: below. [1998] Shotcrete repairs along the median and exterior copings.

Pier #12:
Pier consists of 6 columns (integral with the slab span deck, no bearings). 3 Under deck lights south face cap.

Span #13 (Concrete Voided Slab Span):
2nd St. below, under deck light EB. [1998] Shotcrete repairs along the median and exterior copings. [2006] Underside of the deck has 10 SF of water saturation.

Pier #13:
Pier consists of 6 columns (integral with the slab span deck, no bearings).

Span #14 (Concrete Voided Slab Span):
North slope is below. [1998] Shotcrete repairs were done along median and exterior copings. [2006] Underside of the deck has 12 SF of water saturation & 4 SF of delamination. 2 Under deck lights.

North Abutment:
Type H: strip seal deck joint above with 14 sliding plate bearing assemblies. [2000] NB joint leaking at both ends. Bearings are rusty. [2006] Strip seal is closed to ¾".

PREVIOUS SNOOPER INSPECTIONS

2005 Ken Rand, Mark Pribula, Kurt Fuhrman, Vance Desens, Pete Wilson, Mike Palmer
2004 Mark Pribula, Kurt Fuhrman, Vance Desens, Pete Wilson, Jim Flannigan, John Miller (City of Mpls)
2003 Mark Pribula, Kurt Fuhrman, Vance Desens, Pete Wilson, Bill Nelson
2002* Mark Pribula, Kurt Fuhrman, Pete Wilson, Jerry Oldeen, Bruce Anderson, Mike Palmer
2001 Marl Pribula, Kurt Fuhrman, Vance Desens, Ken Rand, Mike Palmer
2000 Mark Pribula, Kurt Fuhrman, Pete Wilson, Marc Beucler, Mike Palmer, Wayne Tennison Pete Wilson, George Morelli, Rebecca Lane
1999 Kurt Fuhrman, Bill Nelson, Ken Rand, Mike Schadegg, Pete Wilson
1998 Mark Pribula, Terry Moravec, Eric Evens, Kurt Fuhrman, Pete Wilson, Jerry Anderson
1997* Mark Pribula, Terry Moravec, Eric Evens, Kurt Fuhrman, Pete Wilson, John Peterson
1996 Terry Moravec, Eric Evens, Kurt Fuhrman, Pete Wilson
1994 Terry Moravec, Kurt Fuhrman, Pete Wilson
1993 Terry Moravec, Chas Martin, Tom Waks
1991 Chester Martin, Chas Martin, Jerry Anderson
1988 Chester Martin

***Denotes an "In-Depth" Inspection**

APPENDEIX A DIAPHRAGM CRACK LOCATIONS

DIAPHRAGM CRACK LOCATIONS
First Diaphragm South of Pier #3
G1 (East Fascia NB) [99/2000] ¼" crack on top of interior stiffener weld. [2006] No change.
G2 (NB)* [1998] Two 2" holes drilled in web. Crack is contained.
G3 (NB) * [1998] Two ¼" intersecting diagonal holes drilled in top of stiffener welds. [2003] No crack.
G4 (NB)* [1998] Two 2" holes drilled in web. Crack is contained.
G5 (NB)* [1998] Two 2" holes drilled in web. Crack is contained.
G6 (NB) [1998] One 2" hole drilled in web. [2000] Other end of crack is turning downward into the web & was drilled out. Crack is contained.
G7 (NB)* [1998] One 2" hole drilled in web & other end of crack was ground out. [2003] The ground out end is cracked, visible on both sides web, should be drilled out. **[2006] ½" crack exterior beyond drilled hole.**
G8 (SB)
G9 (SB)
G10 (SB)
G11 (SB)
G12 (SB) * [1998] Two 2" holes drilled in web & 1 hole drilled in stiffener. [1999] Crack extends 1" beyond the hole (ground out). [2003] No change.
G13 (SB)
G14 (West Fascia SB)* [1998] One 2" hole drilled in web. [2000] ¾" horizontal crack on exterior flange/web weld (may eventually need drilling), small diagonal crack @ top of interior stiffener weld. [2003] No change.

DIAPHRAGM CRACK LOCATIONS
First Diaphragm North of Pier #3 ***Denotes original 1998 crack locations**
G1 (East Fascia NB)
G2 (NB) Strain gauges on both faces.
G3 (NB)* [98/2000] West side, top flange web weld has ½" crack. Eastside, stiffener weld has a small crack. [2003] No change.
G4 (NB)* [1999] West face, top of stiffener weld small crack, drill out.
G5 (NB)* [2003] Small crack at the top of stiffener weld.
G6 (NB)* [1999] Small crack at top of stiffener weld. Strain gauges on the east face. [2003] No change.
G7 (NB)* [2003] Small crack at the top of the interior stiffener weld.
G8 (SB)
G9 (SB)
G10 (SB)
G11 (SB)* [1998] Two 2" holes drilled in web. Crack is contained.
G12 (SB)* [1998] Two 2" holes drilled in web. Crack is contained.
G13 (SB)
G14 (SB)
G15 (West Fascia SB)* [1998] Two 2" holes drilled in web. Crack is contained.

DIAPHRAGM CRACK LOCATIONS

First Diaphragm North of Pier #4

***Denotes original 1998 crack locations**

G1 (East Fascia NB)
G2 (NB)
G3 (NB)* [1998] Two 2" holes drilled in web. Crack is contained.
G4 (NB)* [1998] Two 2" holes drilled in web. Crack is contained.
G5 (NB)
G6 (NB)
G7 (NB)* [1998] Two 2" holes drilled in web. [2001/03] Both sides, small crack at top of stiffener weld.
G8 (SB)
G9 (SB)
G10 (SB)* [1998] Two 2" holes drilled in web. Crack is contained.
G11 (SB) [99/2000] Small crack at top of stiffener weld. [2003] No change.
G12 (SB)* [1998] Two 2" holes drilled in web & ¼" hole drilled in stiffener weld. Crack is contained.
G13 (SB) [99/2000] Small crack at top of stiffener weld. [2003] No change.
G14 (West Fascia SB) [1999] Small crack at top of interior stiffener weld. [2003] No change.

DIAPHRAGM CRACK LOCATIONS

First Diaphragm South of Pier #9

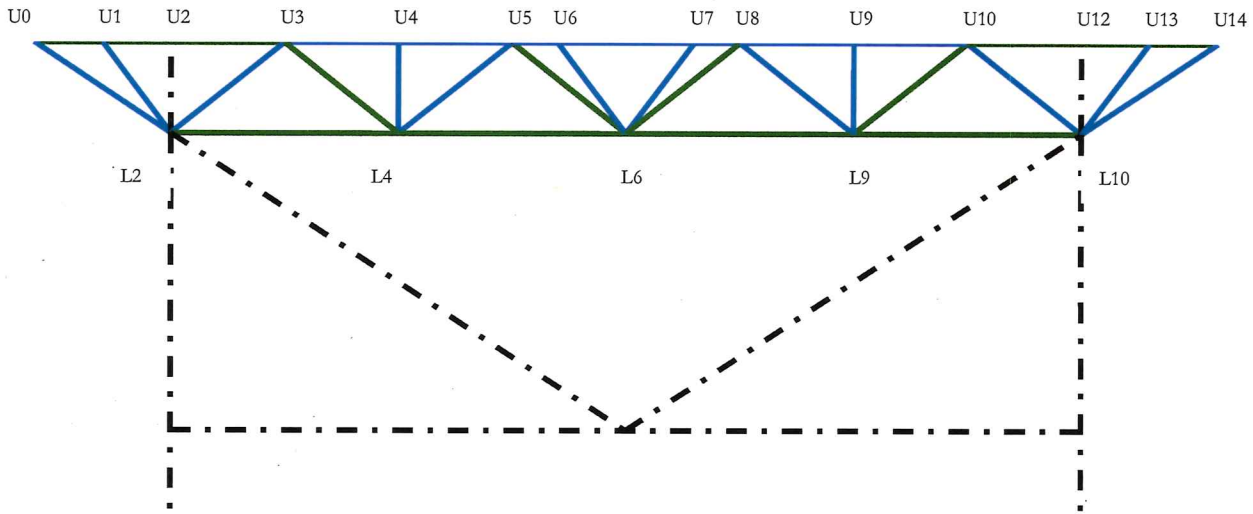
***Denotes original 1998 crack locations**

G1 (East Fascia NB) [2000] Exterior top flange/web weld has a ½" indication. [03] No change.
G1C (NB)
G2 (NB)* [1998] 4 ft. long inverted "U" shaped crack in web (reinforced with bolted plates).
G3 (NB)
G4 (NB)* [98/2000] Small crack in top flange/web weld. [03] No change.
G5 (NB)
G6 (NB)
G7 (NB)
G8 (SB)
G9 (SB)* [1998] Crack in top of stiffener weld. [2003] No change.
G10 (SB)
G11 (SB)* [98/2000] Small crack in top of stiffener weld (east side). [03] No change.
G12 (SB).* [98/2000] Small crack in top of stiffener weld (east side). [03] No change.
G13 (SB):
G14 (West Fascia SB)

DIAPHRAGM CRACK LOCATIONS

First Diaphragm North of Pier #9 *Denotes original 1998 crack locations
G1 (East Fascia NB)
G1B (NB) Stiffeners are welded to the top flange (positive moment).
G1C (NB)
G1D (NB) Stiffeners are welded to the top flange (positive moment)
G2 (NB)
G3 (NB)
G4 (NB* [2000] Two 2" holes drilled in web. Crack contained.
G5 (NB) * [2000] Two 2" holes drilled in web. Crack contained.
G6 (NB)
G7 (NB)
G8 (SB) [2006] Top of west stiffener is working.
G9 (SB)* [98/2000] Crack in top flange/web weld & top of west stiffener weld.
G10 (SB)* [2000] Crack in top flange/ web weld (east side) [2005] No change.
G11 (SB)* [2000] Two 2" holes drilled in web. Crack contained.
G12 (SB).* [2000] Two 2" holes drilled in web. Crack contained.
G13 (SB)
G14 (West Fascia SB)

TRUSS DIAGRAM



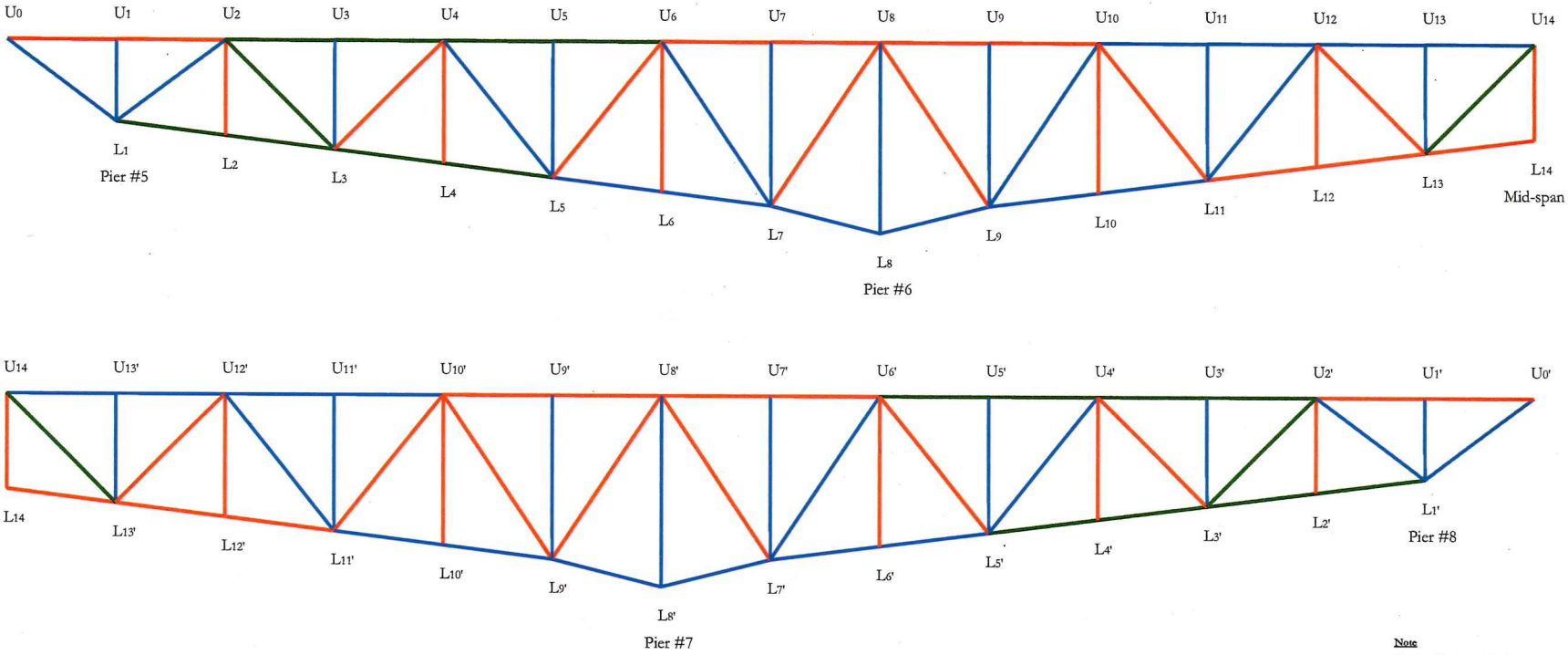
Note

Tension Members in Red
Compression Members in Blue
Reversal Members in Orange
Black Dashed Lines are Secondary Members

Minnesota Department of Transportation
I-35W over Mississippi River at Mpls., MN
Bridge No. 9340

Floorbeam Truss Diagram

TRUSS DIAGRAM



Note

Tension Members in Red
Compression Members in Blue
Reversal Members in Orange

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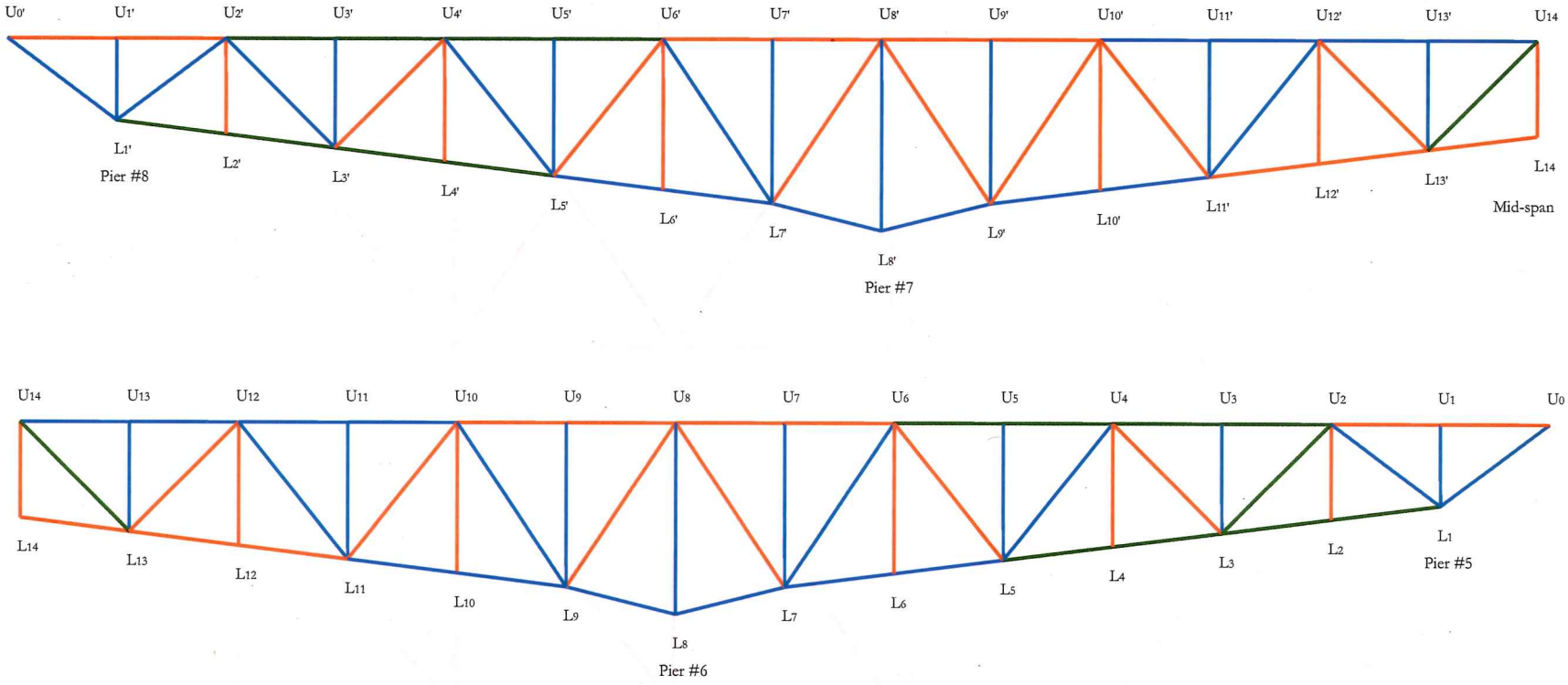
Bridge No. 9340

Truss Diagram (Eastside)

TRUSS DIAGRAM



Note
Tension Members in Red
Compression Members in Blue
Reversal Members in Orange

Minnesota Department of Transportation
I-35W over Mississippi River at Mpls., MN
Truss Diagram (Eastside)

Bridge No. 9340