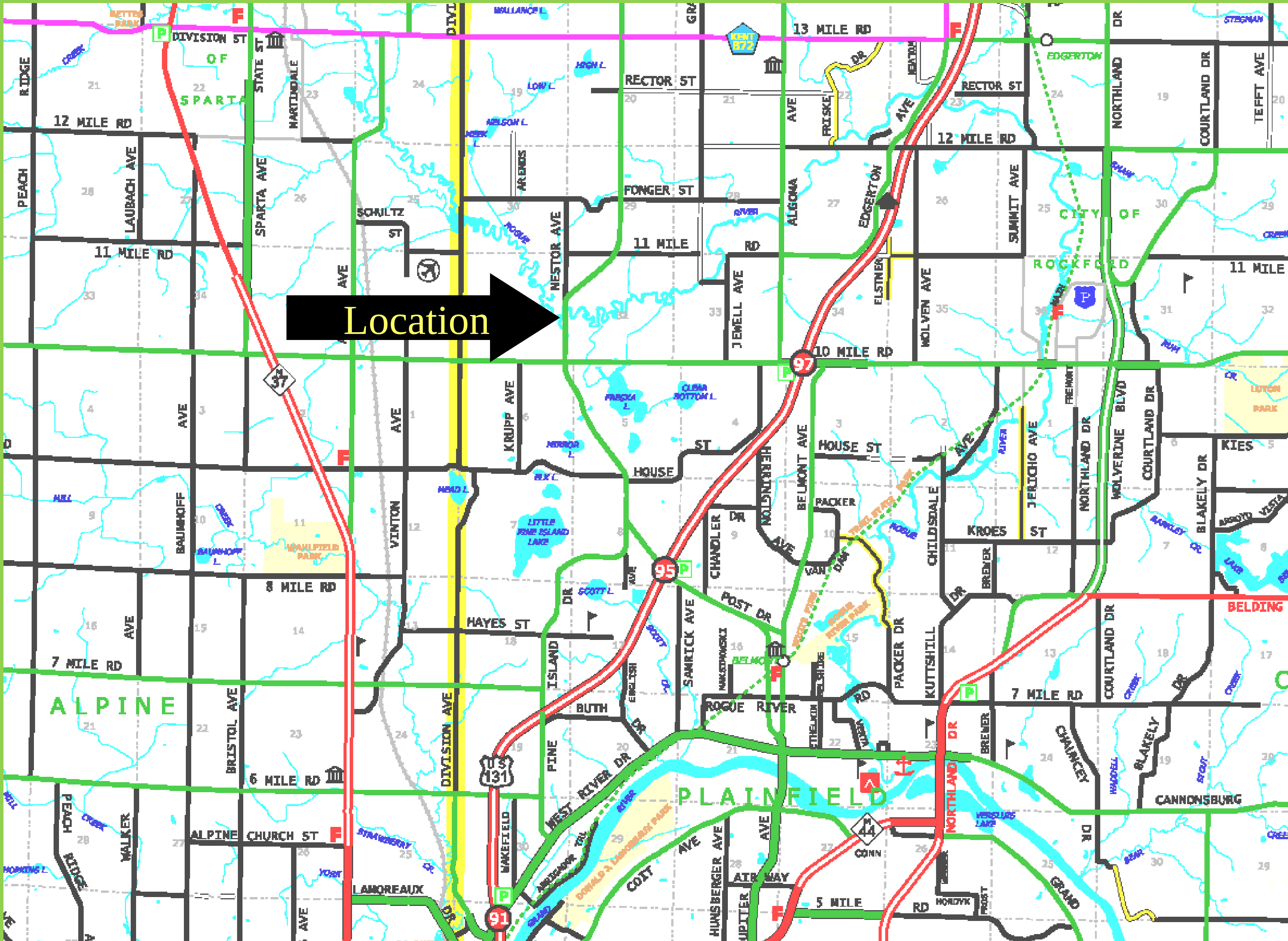
Kent County
Road Commission

2015 Bridge Conference

Bay City Michigan
March 18, 2015

Pine Island Drive Bridge Restoration

LTU Beam Testing Update



Location
13 MILE RD
DIVISION ST
CITY OF SPARTA
RECTOR ST
12 MILE RD
FONGER ST
11 MILE RD
SCHULTZ ST
NESTOR AVE
JEWELL AVE
ALGOMA AVE
EDGERTON AVE
SUMMIT AVE
NORTHLAND DR
COURTLAND DR
TEFFT AVE
CITY OF ROCKFORD
10 MILE RD
HOUSE ST
KRUPP AVE
VINTON AVE
BAUMHOFF AVE
SPARTA AVE
LAUBACH AVE
PEACH RIDGE
8 MILE RD
HAYES ST
7 MILE RD
ALPINE
6 MILE RD
ALPINE CHURCH ST
LAMOREAUX
DIVISION AVE
WAKEFIELD
PINE ISLAND DR
WEST RIVER DR
COIT AVE
PLAINFIELD
ROGUE RIVER RD
BELMONT AVE
HERRINGTON AVE
POST DR
SAMRICK AVE
CHANDLER DR
PACKER DR
KUTTSHILL DR
CHILDSDALE
WOLVERINE BLVD
JERICHO AVE
KROES ST
BREMER
BELDING RD
CANNONSBURG
KIES
BLAKELY DR
5 MILE RD
AIRWAY
HUNSBERGER AVE
JUPITER
BIRCH
WALKER AVE
BRISTOL AVE

Original truss bridge being removed in 1925

Typical 1920’s truss bridge

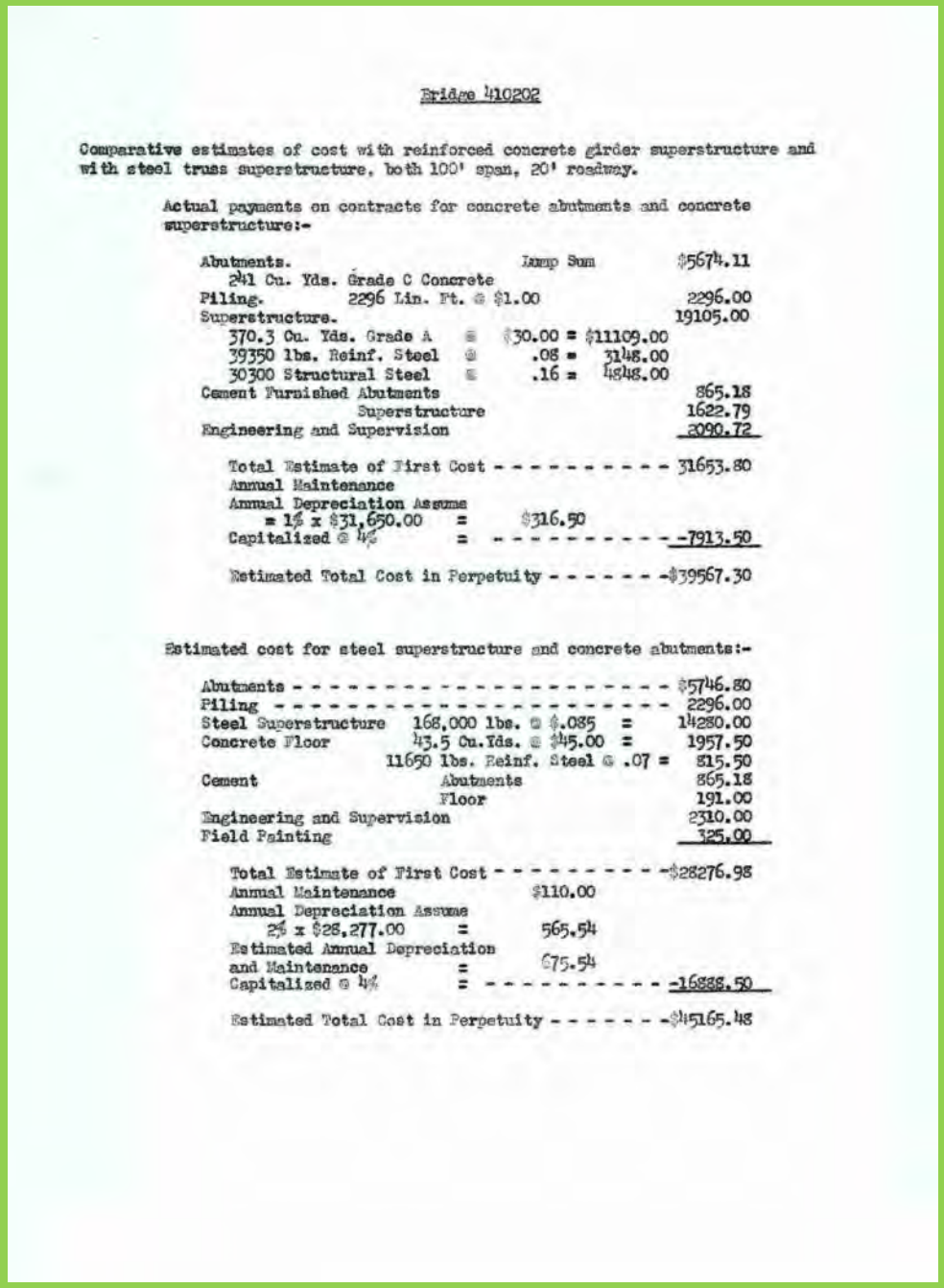
Steel vs Concrete Life Cycle Costing

- Concrete
- First cost $31653
- No annual maintenance
- Depreciation $7913

- Cost in Perpetuity $39,567

- Steel
- First Cost $28,276
- Est annual maint 110
- Depreciation $16,888

- Cost in Perpetuity $45,165



Bridge 410202

Comparative estimates of cost with reinforced concrete girder superstructure and with steel truss superstructure, both 100' span, 20' roadway.

Actual payments on contracts for concrete abutments and concrete superstructure:-

Abutments.	Lump Sum		$5674.11
241 Cu. Yds. Grade C Concrete			
Piling.	2296 Lin. Ft. @ $1.00		2296.00
Superstructure.			19105.00
370.3 Cu. Yds. Grade A	@ $30.00 =	$11109.00	
39350 lbs. Reinf. Steel	@ .08 =	3148.00	
30300 Structural Steel	@ .16 =	4848.00	
Cement Furnished Abutments			865.18
Superstructure			1622.79
Engineering and Supervision			2090.72
Total Estimate of First Cost			31653.80
Annual Maintenance			
Annual Depreciation Assume			
= 1% x $31,650.00 =	$316.50		
Capitalized @ 4% =			-7913.50
Estimated Total Cost in Perpetuity			-$39567.30

Estimated cost for steel superstructure and concrete abutments:-

Abutments			$5746.80
Piling			2296.00
Steel Superstructure	168,000 lbs. @ $.085 =		14280.00
Concrete Floor	43.5 Cu. Yds. @ $45.00 =		1957.50
	11650 lbs. Reinf. Steel @ .07 =		815.50
Cement	Abutments		865.18
	Floor		191.00
Engineering and Supervision			2310.00
Field Painting			325.00
Total Estimate of First Cost			-$28276.98
Annual Maintenance		$110.00	
Annual Depreciation Assume			
2% x $28,277.00 =		565.54	
Estimated Annual Depreciation and Maintenance =		675.54	
Capitalized @ 4% =			-16888.50
Estimated Total Cost in Perpetuity			-$45165.48

Bid Documents

- Notice to Contractors 1 page
- Notice to Bidders 3 pages
- Special Provisions and Bid Sheet 1 page
- Plan sheets - 2

SPECIFICATIONS
State Reward Bridge No. 410202

The specifications to be followed in performing this work shall be the Department's "General Specifications" for bridges. Fifth Edition 1922, supplemented by the "Additions and Changes"Effective September 20th, 1922, the attached "Instructions to Bidders" of April 3rd, 1923, and such special provisions as are contained herein.

STATE CEMENT: Cement will be furnished by the State f.o.b. Englishville.

SPECIAL SPECIFICATIONS

Falsework Piling must be of 10 ton capacity with 12 inch butts, 6 inch tips with alignment joining centers of butts and tips falling inside the pile throughout. Piles need not be peeled.
Bents are not to be spaced over 10 feet center to center. 3 Piles per bent centered under each girder, with 2 intermediate piles per bent, also outrigger piles from outside bracing to be placed 9 feet from center of girder with a total of 10 piles per bent are required. All floor lagging is to be 2 inch T & G, no tar paper being permissable.
Girder joist shall consist of 12 2x12 yellow pine per girder or equivalent.
Complete longitudinal bracing consisting of 2 planes of 3x8 wales and cross braces will be required in alternate panels, extending to low water level and similar bracing of one plane type will be required at each bent. 6"x6"x2'0" oak wedges will be required at each bent for complete control of camber. Concrete buggies are to be supported in such a manner that deflection of supports and vibration will not affect the work being cast.
Sponting will not be permitted.
All exposed surfaces except bottom of floor inside of girders is to be given a carborundum rub.
All excavated material handled in connection with this job is to be disposed of as directed by the Engineer.
No concrete is to be cast in freezing weather

The bridge floor is to be cured by the ponding method, damming both ends of the bridge and sealing all drain openings and keeping the floor flooded with not less than 1½" depth of water at all times during a two week's period after the pouring of any section of the floor.
The superstructure is not to be merely moistened, but is to be kept damp, using burlap or straw coverings and keeping the forms wet constantly for a period of not less than two weeks after pouring any unit.

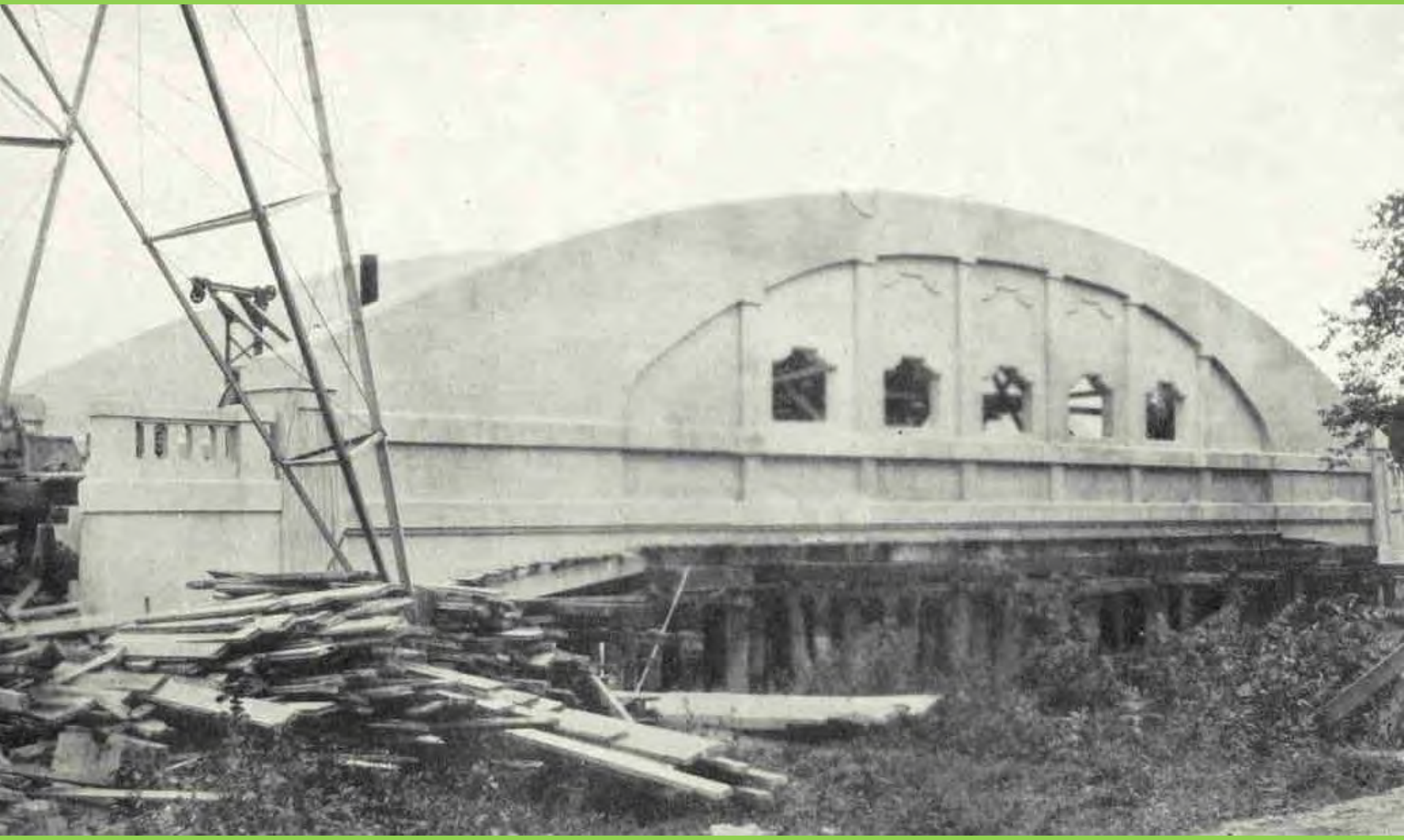
ITEMIZED BID

Approx.Quantity		Item of Work	
(1) 360.3	Cu.Yds	Grade A concrete	----------
(2) 39350	Lbs.	Bar Steel Reinforcement	----------
(3) 30300	"	Structural Steel Reinforcement	----------

Notice
Falsework sketches must be submitted with the proposal in order to entitle it to consideration as time is an essential element on this job.
It is specifically understood that the items and prices as given above constitute full and complete basis for compensation for all work required in connection with this Proposal.

Br. 410202

Note the falsework



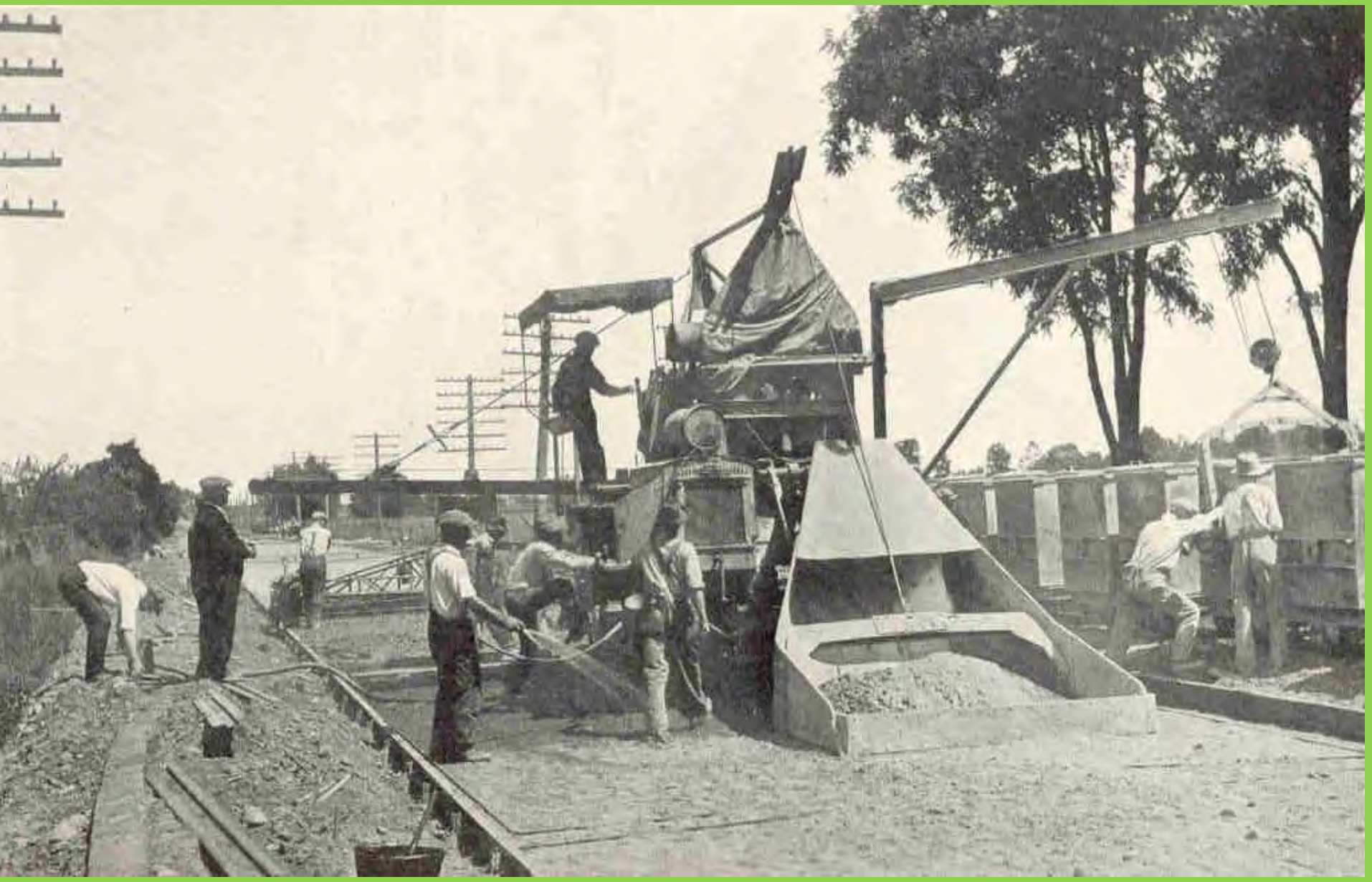
The “batch plant” on the deck with a barrel of state supplied cement

Typical “improved” road of the 1920’s

Road Commission WW 1 surplus trucks

This is our first new truck, purchased to replace old worn-out war equipment.

Road Commission's first truck purchased new -1924 United- built in GR

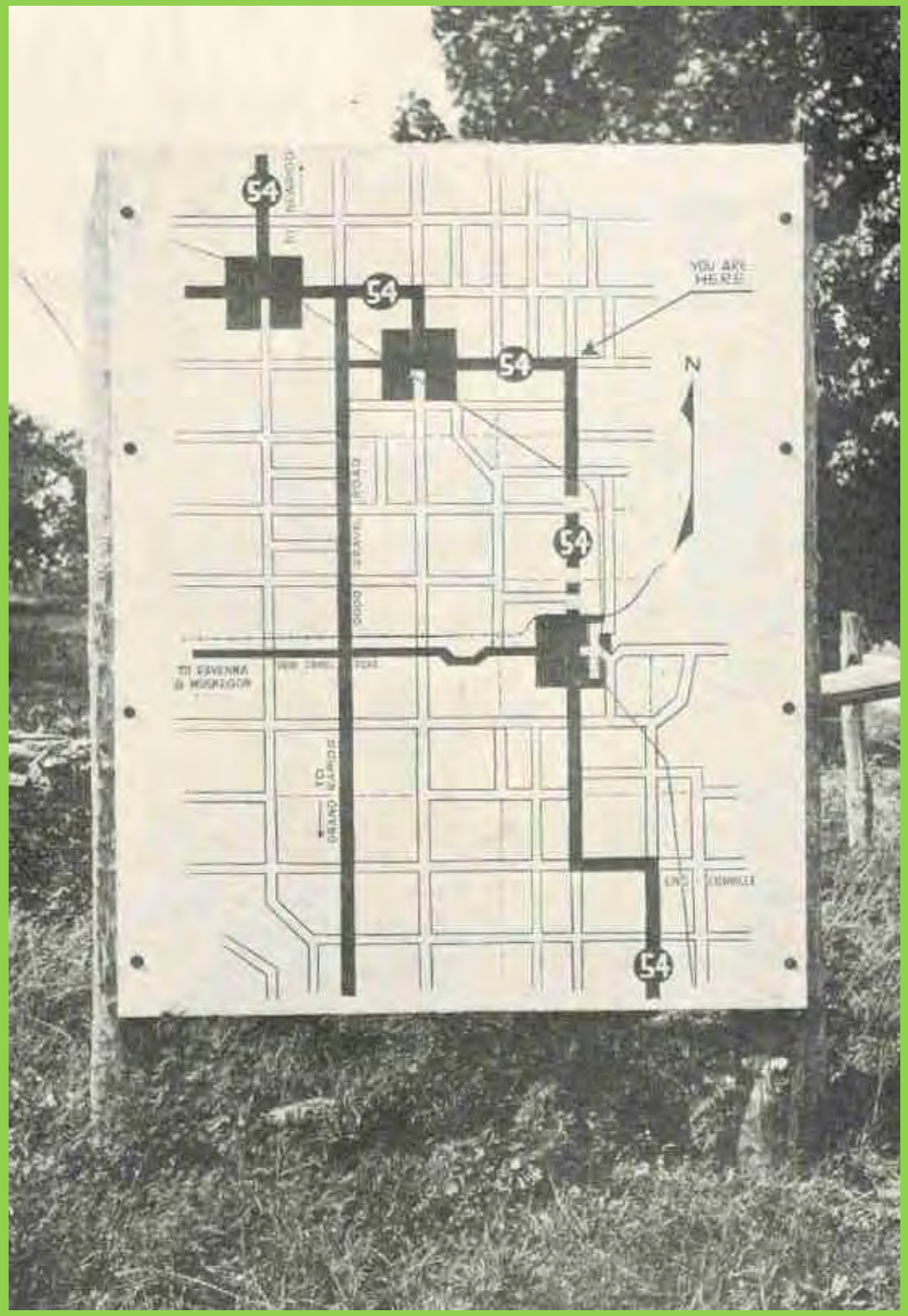


Concrete paving train – material delivery by narrow gauge RR

Gasoline engine powered excavator

State of the art

Detour signing



Asphalt paving – where’s the paver?

It’s an “Armstrong paver” – asphalt mixed on site in a concrete style batch mixer

Have to have those pavement markings (and a cigarette ☺)

Road Commissioners inspecting the “New” concrete pavement surface grinder

Bridge Replacement Program

- 1968-1977 local bridge program
  - 3-party agreement

25% township	$35,000 / year
25% County of Kent	$35,000 / year
50% KCRC	$70,000 / year

Bridges by contract

Culverts by county forces (“the bridge crew”)

- 2nd 10 year program 1979-1988
  - 64 bridges / culverts
    - 25% County of Kent $61,000 / year
    - 10% Townships $18,000 / year
    - 65% KCRC $167,000 / year

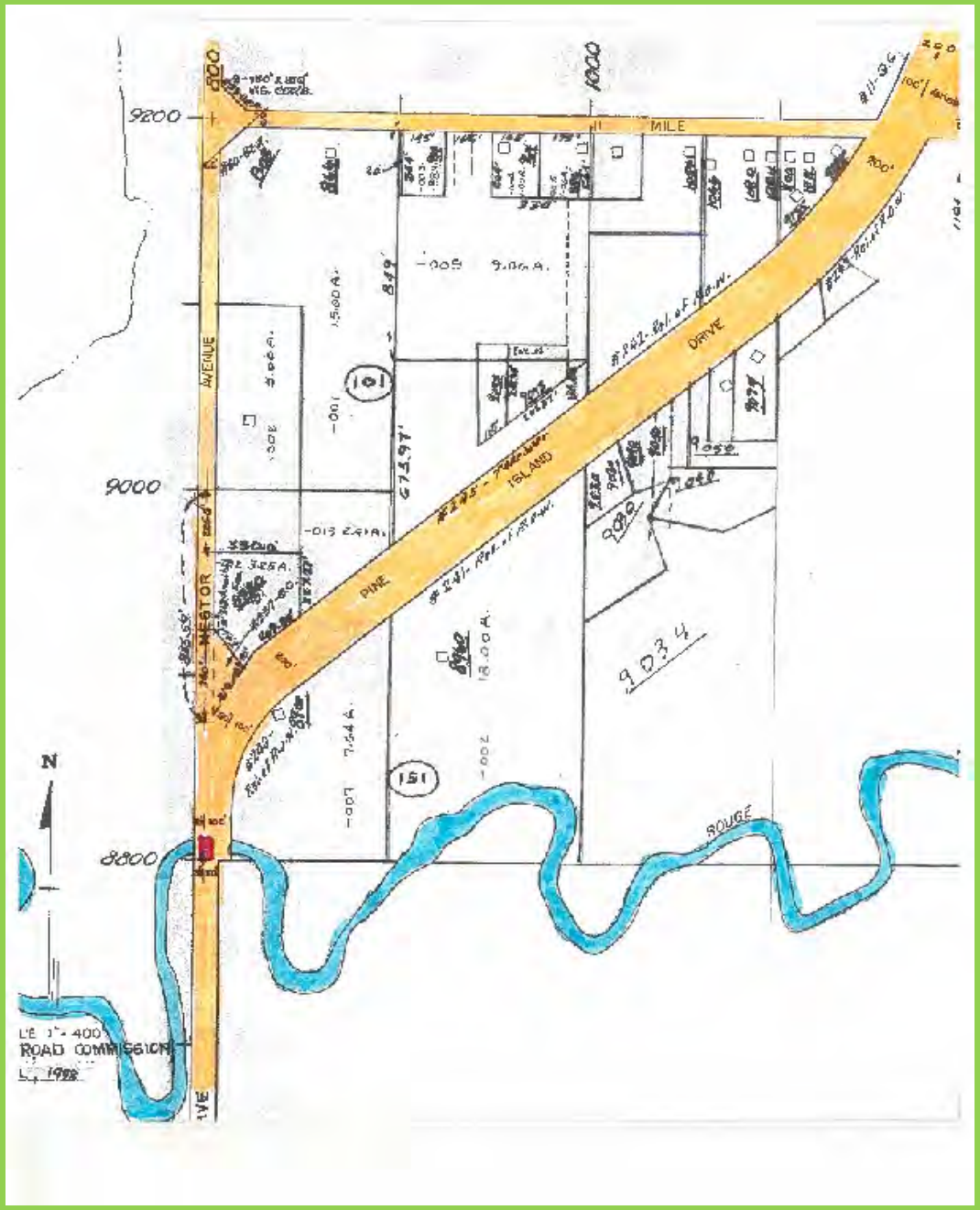
Very successful in getting bridge and culvert needs addressed

Manager ended the bridge crew

1983 Replacement

- Functionally obsolete – only 20 feet wide
- Structurally sound, minor deterioration
- Low traffic count – 700ADT
- $300,000 to remove and replace
- $215,000 to build a second bridge

Recommendation - leave until the 2nd is needed.


9200
9000
8800
MILE
AVENUE
DRIVE
PINE
ISLAND
ROUGE
9034
N
SCALE 1" = 400'
ROAD COMMISSION

2006

Western Michigan Branch

American Society of Civil Engineers nominated the bridge as an

ASCE State Historic Site

Algoma Township Historical Society

pursued State Historic Site Status

2014 Enhancement Grant

$193,500 for restoration / rehabilitation

Contract amount $261,791

Contractor L.W. Lamb

This Old House is a lot like This Old Bridge

Recent Photos - 2009

Despite the bridge's age – it still is a graceful structure

Modest Spalling, Graffiti, Mold, and Failed Past Repair Efforts All Contributed to Make the Bridge a Bit of an Eyesore

But For 90 Years Old – It could be Worse

And In Some Places It Was Worse….

Amazing What You Can Do in 24 Hours

First Step – Milling. This is a lot like Christmas Morning – You Never Know What You'll Get….

In June 2014 We Cleaned Some Test Areas So We Could Match the Color (hopefully)

In Hindsight, We Should Have Initiated the Test Cleaning Process in June 2013, Not 2014….

My stomach went into a knot when I saw this…

This was easier to stomach

Only minor chipping was required on the inside faces of the “truss”

Vertical Reinforcement in “pilaster”

After Hand Chipping – Our Next Step Was to “Soda Blast” the Interior of the Truss

° Soda Blasting is Similar to “Sand Blasting”, except Baking Soda is Used as the Medium

°Baking Soda is “Soft” and Not Really Abrasive

°Baking Soda also provides some moderate cleaning properties, much like consumer products with Baking Soda…

“Inside” Of The Bridge After Soda Blasting

After Soda-Blasting (7/25/14)

East Side of Exterior – After Power Washing

All areas have been soda blasted, the lower area had also been sand blasted. The lower area used to have epoxy over it

Former Epoxy Covered Area – all concrete substrate was not “perfect” – some surfaces still harbor a little epoxy

S-2 Trial Mix for Balustrade – 5 Days After Placement

CL Mixes at 5 days – we are very concerned……(too brown)

Overall – color results were good with a few “initial outliers”

More Patchwork…..

TEXTURE WILL BE ENHANCED BY APPLICATION OF “SAND-CEMENT” TEXTURE

SMALL VOID –(THIS WAS FILLED). SPRUE WAS REMOVED TOO

Same Patch Area, 3 Weeks Before

Finished Results….

Interior, East Side, Before

Interior, East Side, After

West Fascia - After

East Fascia - Before

East Fascia - After

Lessons Learned:

* For this situation, it seems power washing is almost as good as soda blasting

* If your bridge has an HMA overlay, it probably has some “issues” on the underlying deck

* Color match and attention to detail when using latex-modifed patching mix are critical

*Surface Treatment/Texturing should be mentioned in any specification


MICHIGAN
HISTORIC SITE
PINE ISLAND DRIVE
BRIDGE
The Pine Island Drive Bridge is a
rare Michigan example of a
reinforced concrete rainbow arch
bridge. A type of through arch
design, this bridge, built between
1922 and 1924, replaced a steel
truss bridge. The low river banks
at the crossing of the Rogue Rive
required the supporting trusses
be raised abo
bed of t
one-hundred-f
n, giving
bridge its unus
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by Michigan
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Department brid
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lick, PE, a
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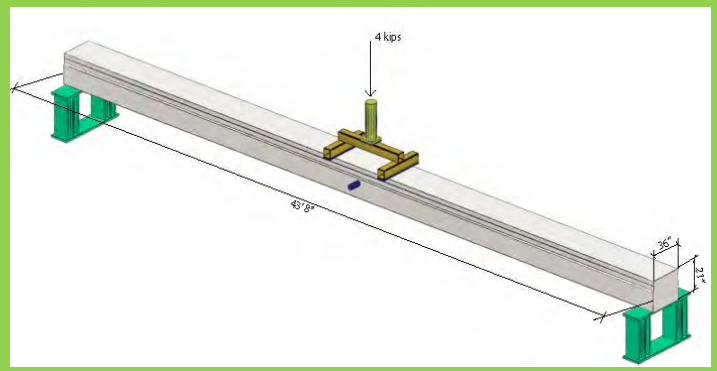
Lawrence Technological University Beam Testing

- 3 salvaged beams tested
- Last one broke on October 31st, 2104

Field Specimens from Kent County - Decommissioned Box Beams



Methods: Ultrasonic Assessment, Electro-chemical, MFL, In-situ Hardness & Flexural Residual Capacity

Overview of Plainfield Bridge #6, Childsdale Avenue






Objectives

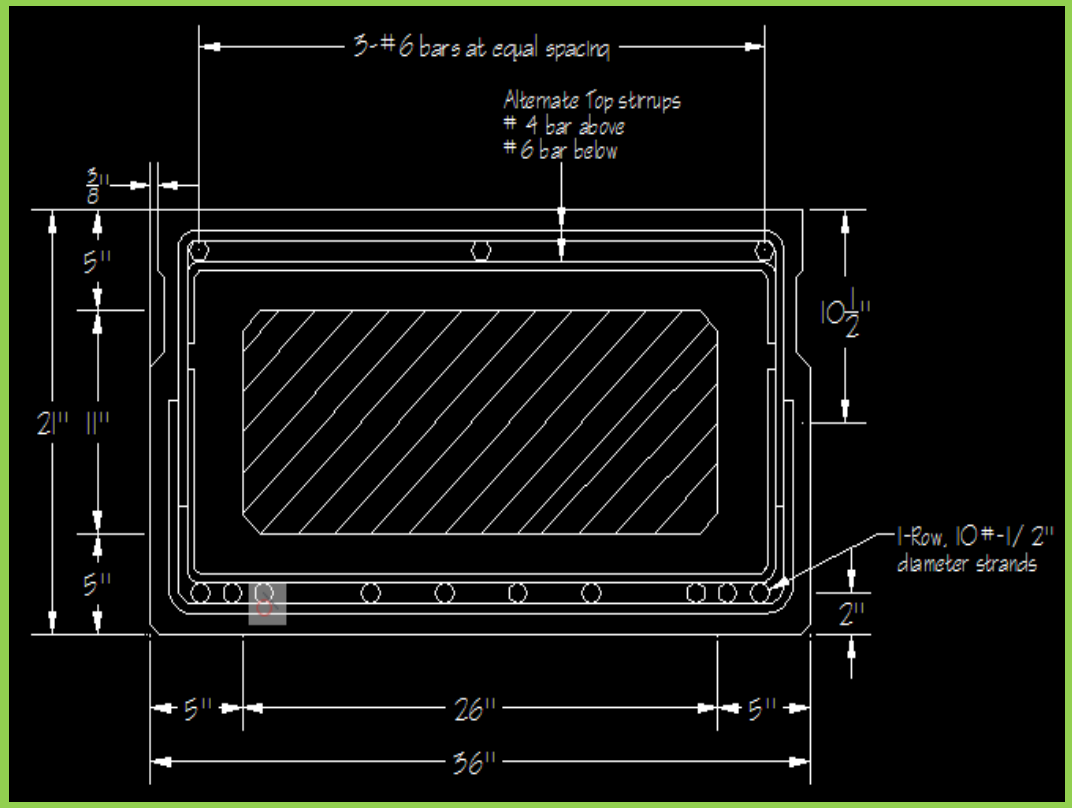
- Evaluate the residual flexural strength of 3 side-by-side box beams decommissioned after 35 years of service due to deterioration.

- Assess the observed deterioration in both concrete quality and prestressed strands and relate to flexural capacity of beams.

Nondestructive Testing Methods

- ultrasonic assessment for delamination and void detection
- electro-chemical half-cell assessment for detecting corrosive environment
- impact hammer assessment of surfaces to detect variations and potential delamination
- magnetic flux leakage to determine loss of cross sectional area of rebar and strands.

Salvaged Beam Configuration



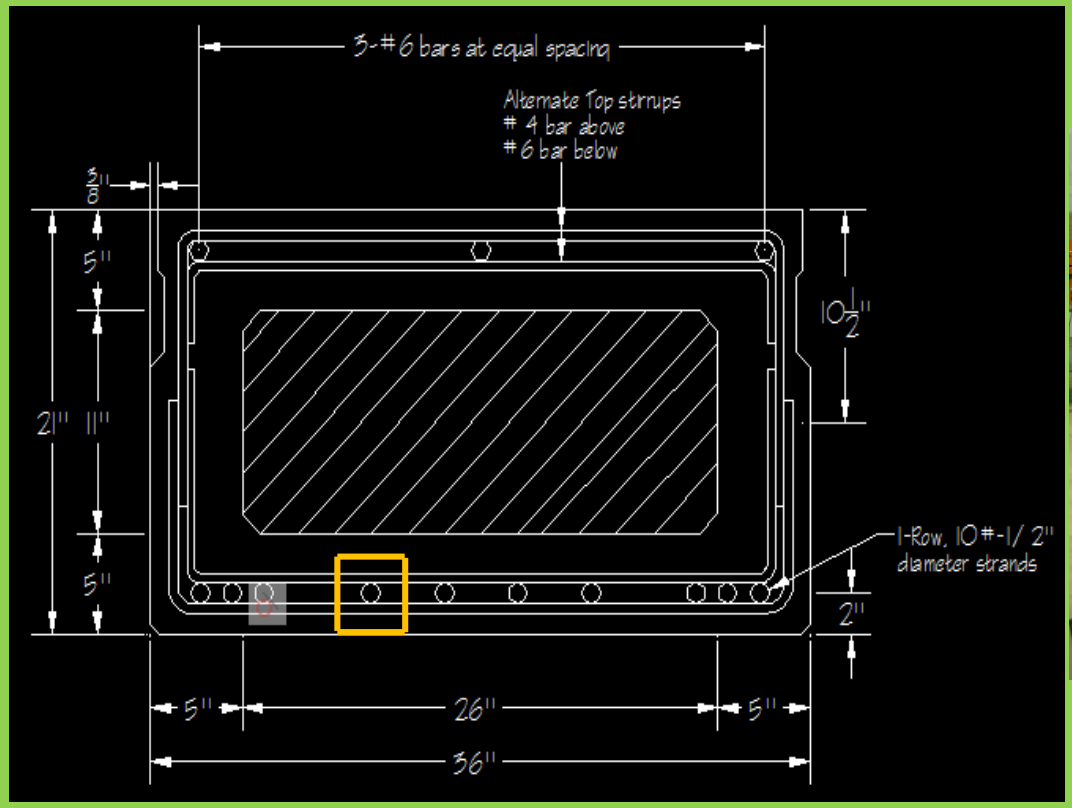
Typical Cross-section

Each beam was 43’-8’’ long, 36’’ wide and 21’’ deep.

Selected beams:

- 2 exterior beam,
- 1 interior beams

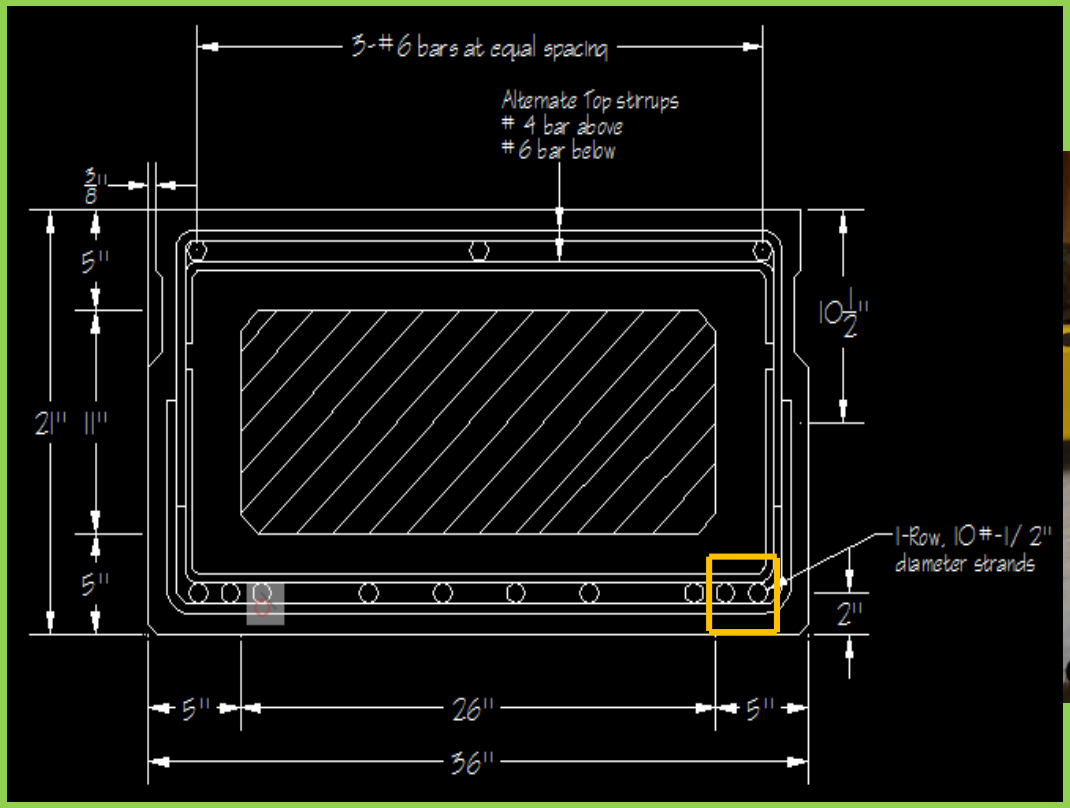
Evaluation of area without significant signs of corrosion



Scanning Strand #4

Scanning on Less Corroded Strand

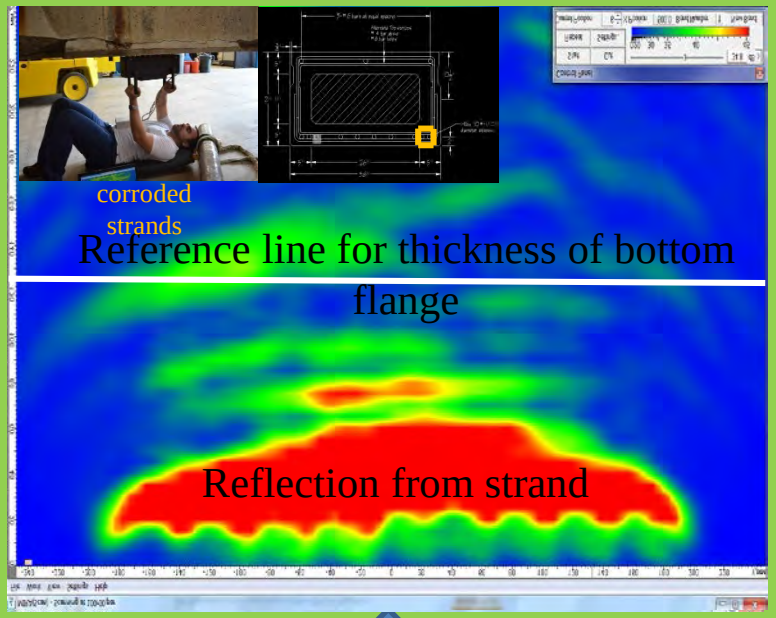
Evaluation of area with significant signs of corrosion



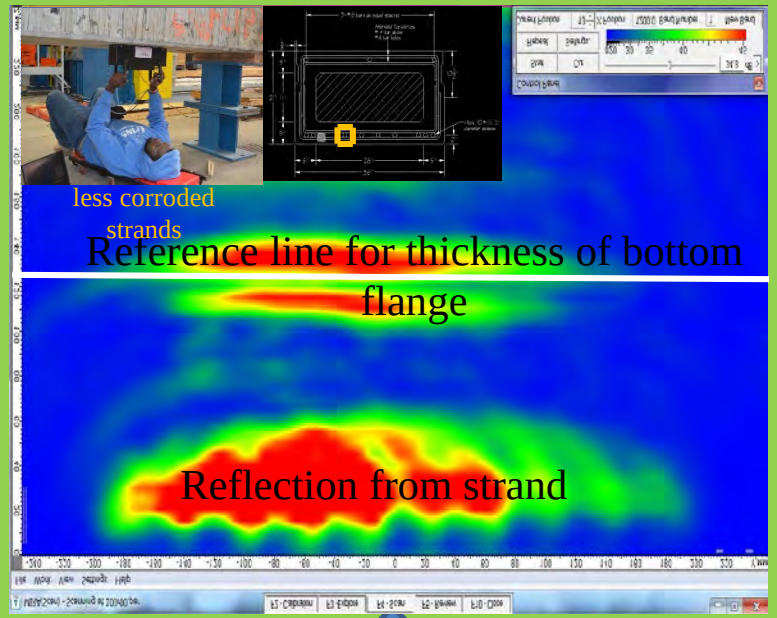
Scanning Strands 9 & 10

Scanning on Corroded Strands

Comparison – Salvaged Beam #1



Scanning at 100 kHz



Scanning at 100 kHz

Electro-chemical Half-cell Assessment of Salvaged Beams

Half-cell potential measurement of bottom strands

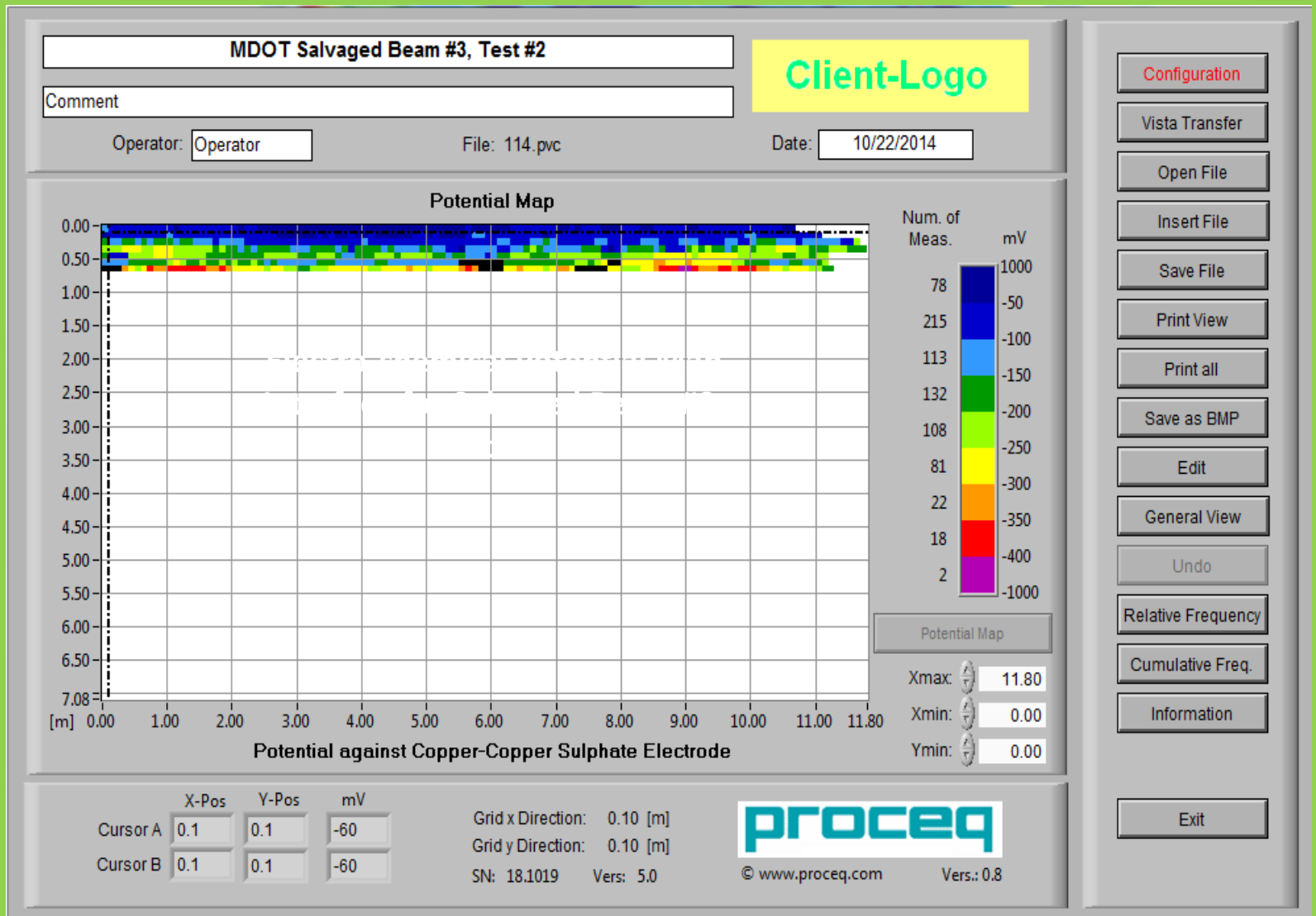
6”x6” grids mapped at the bottom of the box beams.

Readings taken from the intersection of these grids.

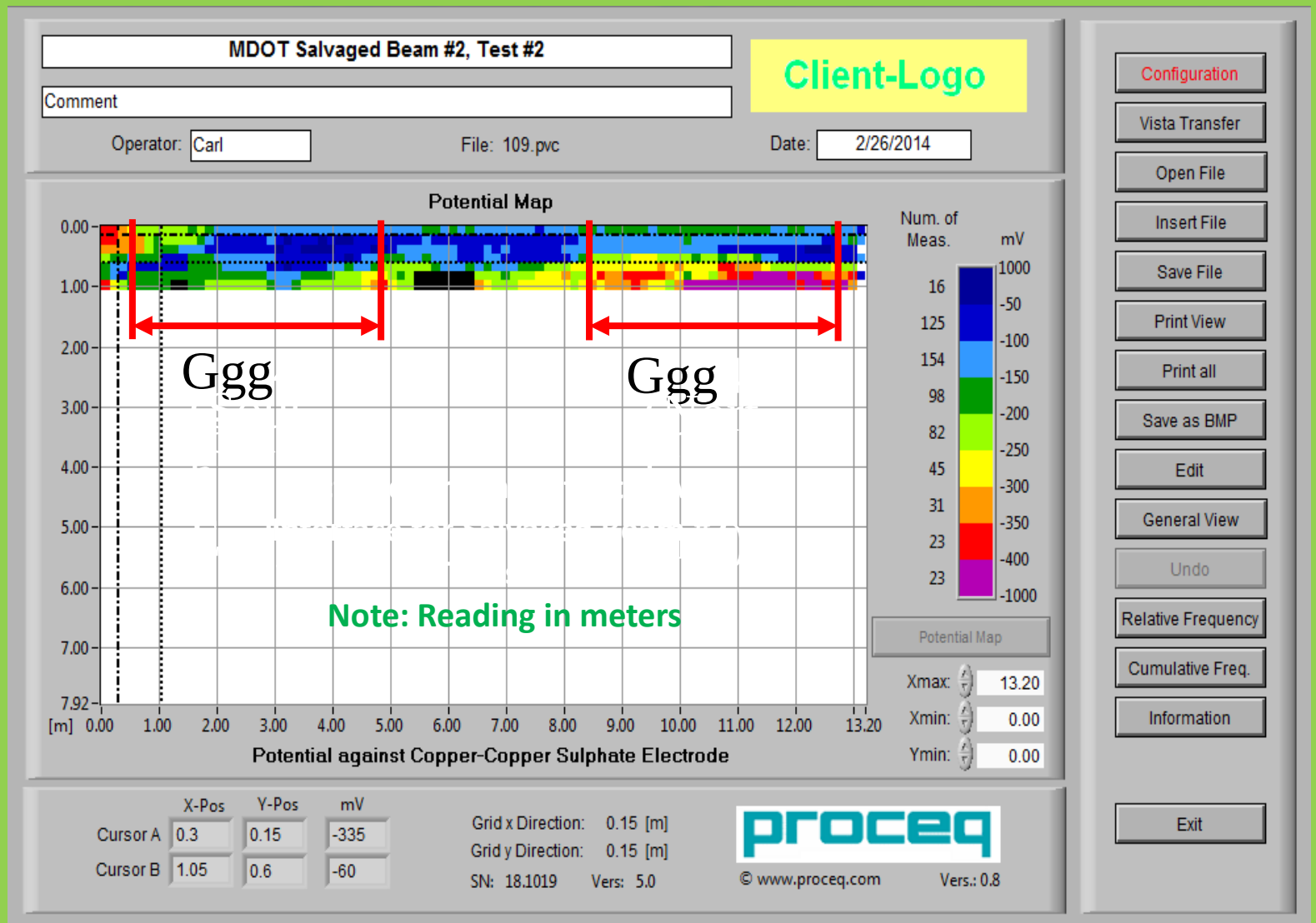
ASTM C876 Half cell potential(mv)
Chance of corrosion

- < -500 – Visible corrosion
- -350 to -500 – 95%
- -200 to -350 – 50%
- > -200 – 5%

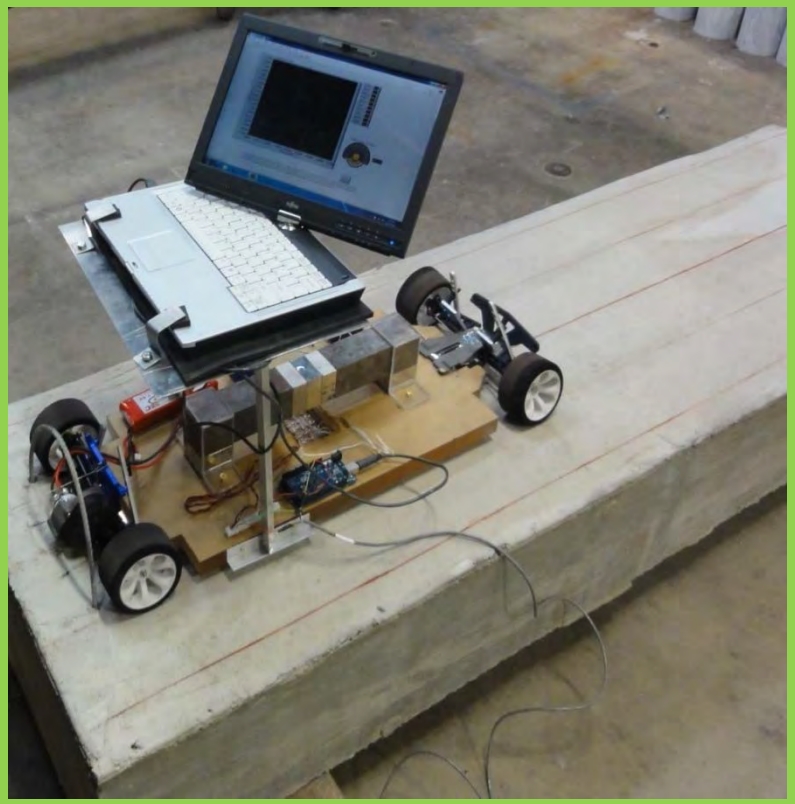
Half-Cell Potential Maps from Salvaged Beam #3 Test 2

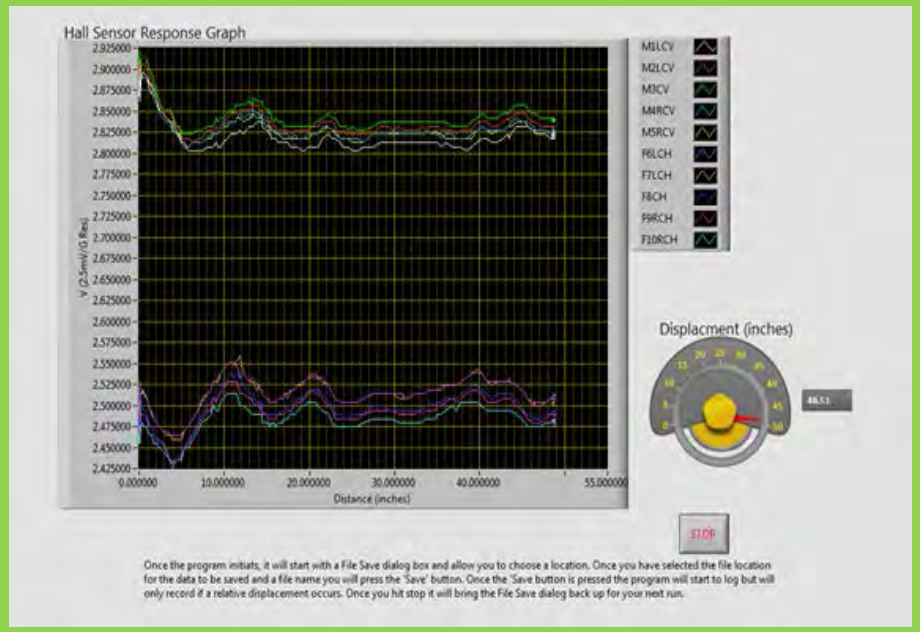


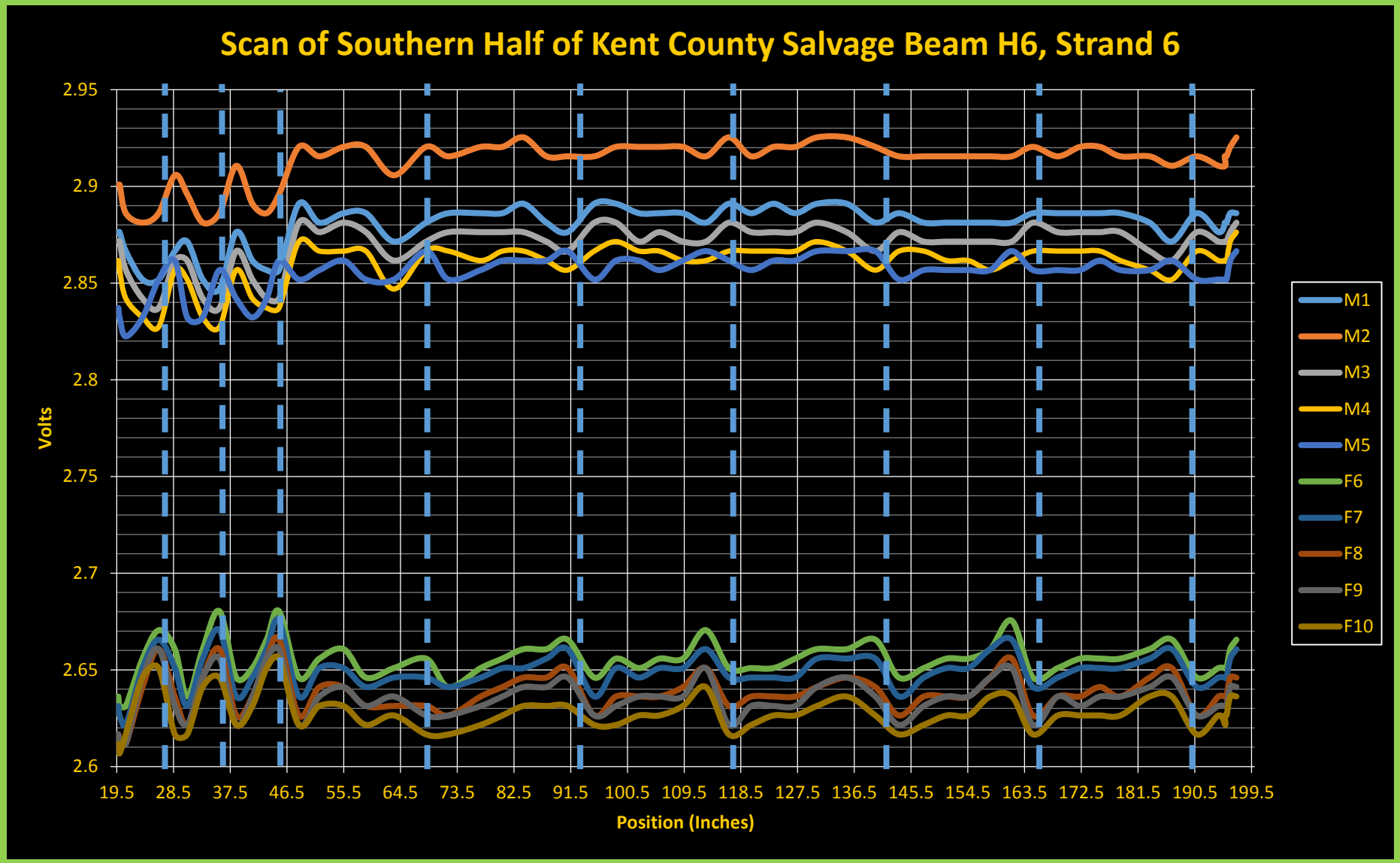
Half-Cell Potential Maps from Salvaged Beam #2 Test 2



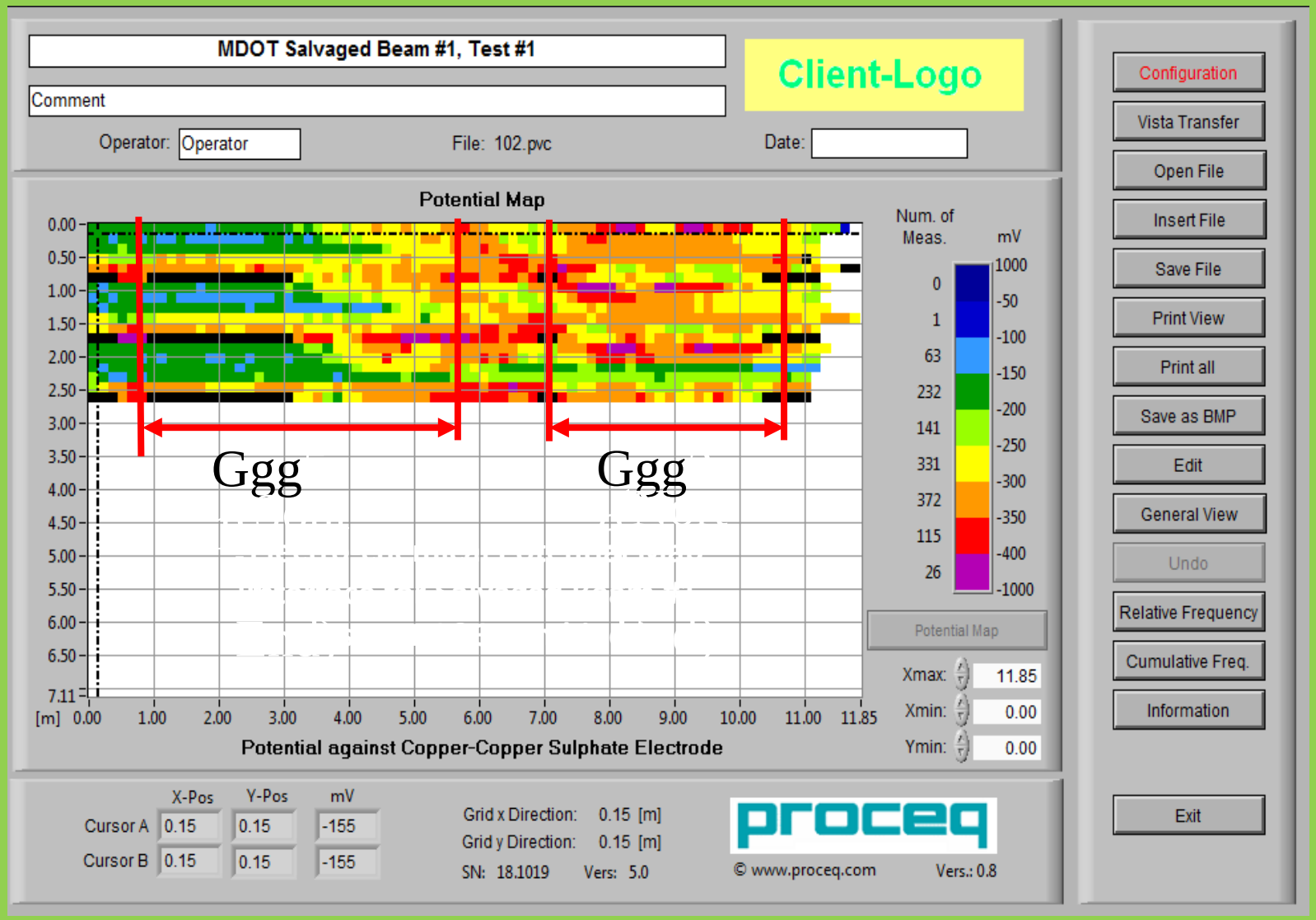
Magnetic Flux Leakage



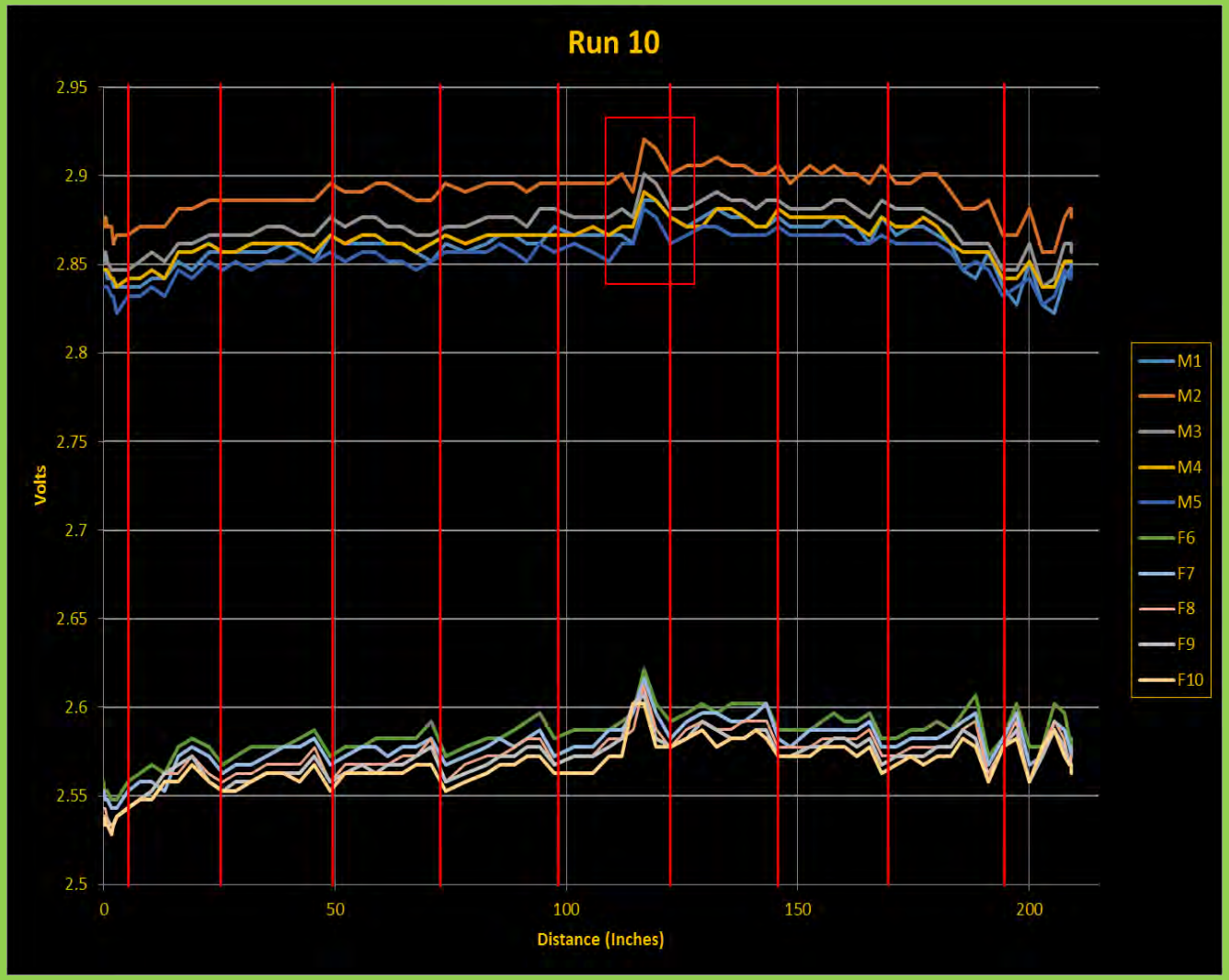



Scan of Southern Half of Kent County Salvage Beam H6, Strand 6
Volts
2.95
2.9
2.85
2.8
2.75
2.7
2.65
2.6
19.5
28.5
37.5
46.5
55.5
64.5
73.5
82.5
91.5
100.5
109.5
118.5
127.5
136.5
145.5
154.5
163.5
172.5
181.5
190.5
199.5
Position (Inches)
M1
M2
M3
M4
M5
F6
F7
F8
F9
F10

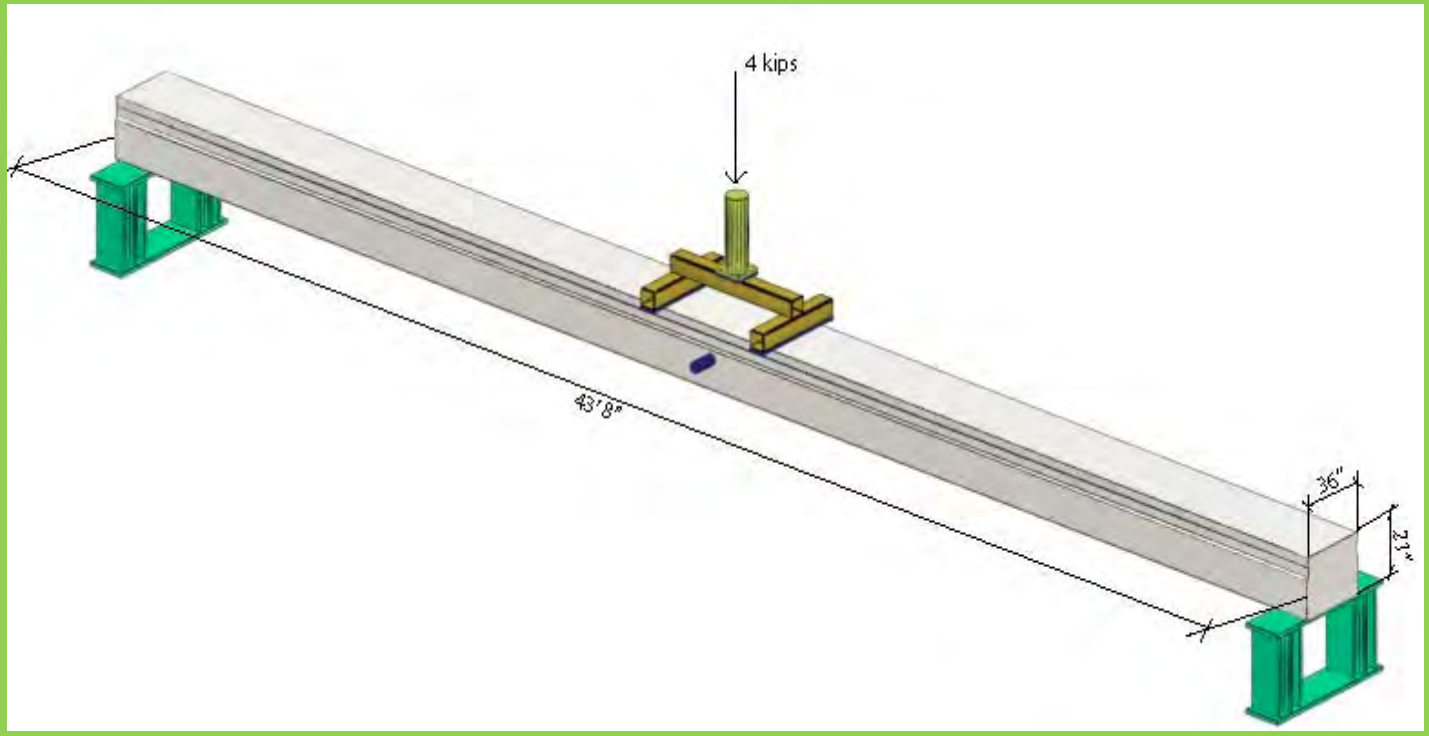
Half-Cell Potential Maps from Salvaged Beam #1 Test 1, 2 & 3



Graphical Representation S3-North End, Run #10, Salvaged Beam #1.



Flexural Testing of Salvaged Beams



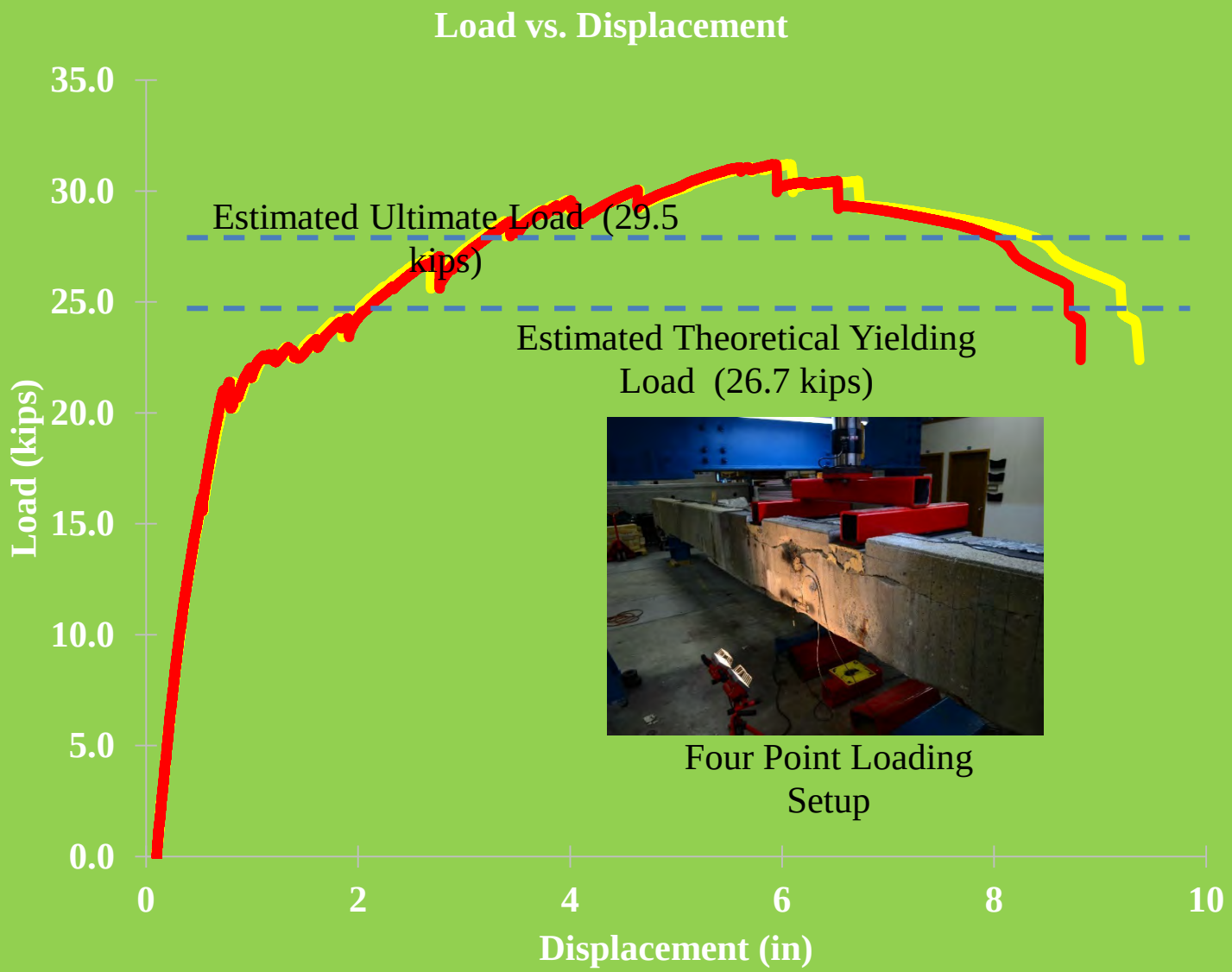
Loading Set-up for Salvaged Beam

Failed Beams

Salvaged Beam #3 (A1)

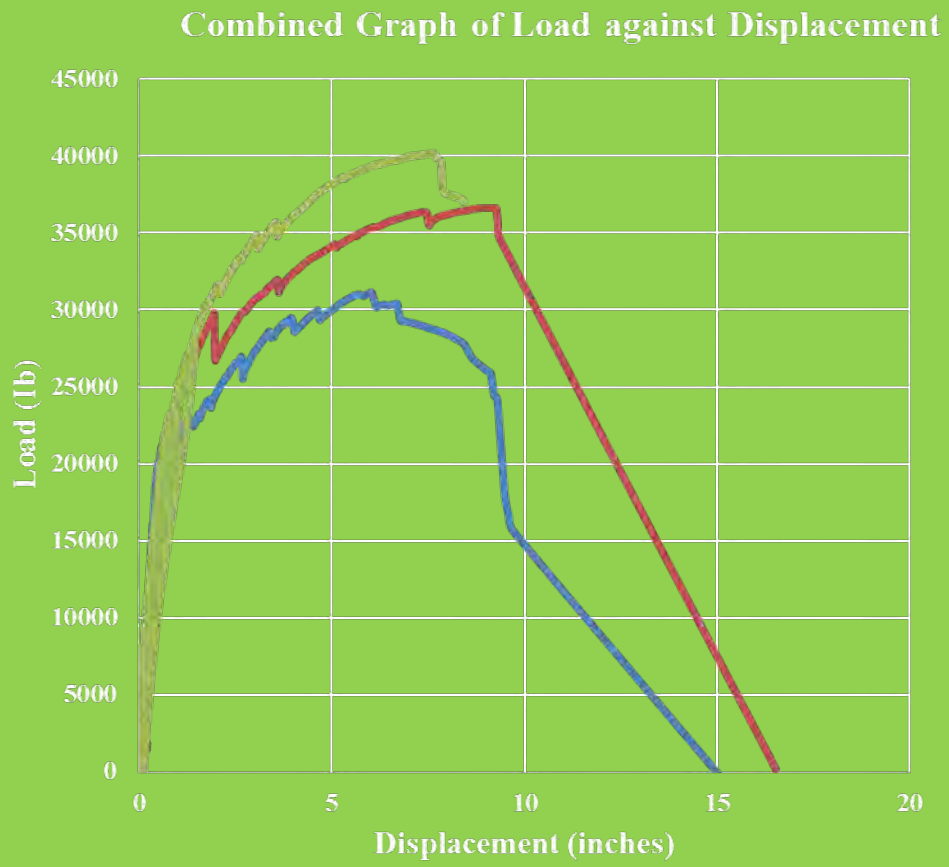
Salvaged Beam #1 (J11)

Experimental Results of Residual Flexural Testing of Salvaged Beam, J11



Four Point Loading Setup

Experimental Results of Residual Flexural Testing of Salvaged Beams: J11, H6 &A1



Beams	Cal. Ultimate Load (lb)	Assumped Cross-sectional Area Loss
Beam #1 (J11)	29500	20% , 8 Strands Actively Engaged
Beam #2 (H6)	39096	20%, 10 Strands Actively Engaged
Beam #3 (A1)	42011	15%, 10 Strands Actively Engaged

[illegible]	Ultimate Load (lb)	Displacement (inches)
Beam #1 (J11)	31200	6
Beam #2 (H6)	36970	9
Beam #3 (A1)	40160	7.5

Where do we go from here?

- Testing has been completed on 3 beams
- There is a correlation deterioration and the strength of the beam with the testing that has been done

- Additional beams should be tested to increase the sample size and verify the results so far.
- Develop a methodology to correlate the data collected to a load rating.

- Questions