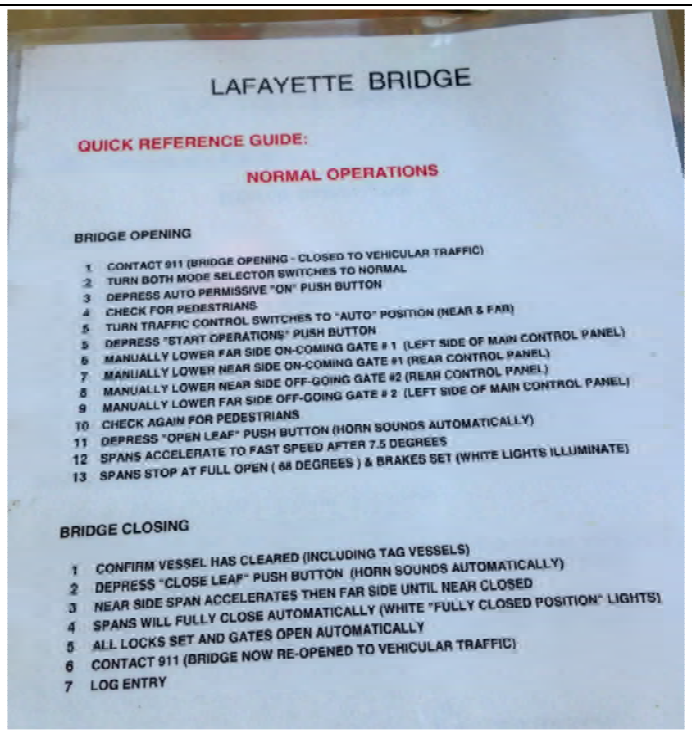
ELECTRICAL PHOTOGRAPHS



LAFAYETTE BRIDGE

QUICK REFERENCE GUIDE:

NORMAL OPERATIONS

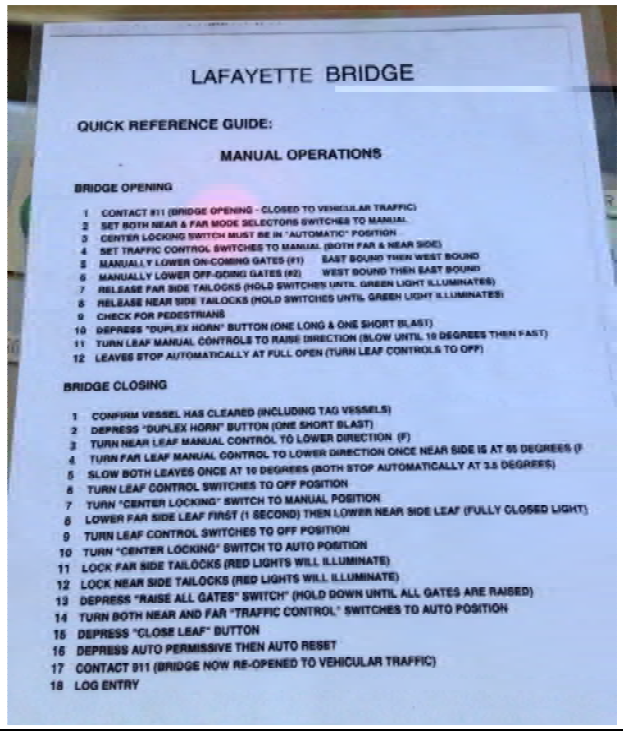
BRIDGE OPENING

1 CONTACT 911 (BRIDGE OPENING - CLOSED TO VEHICULAR TRAFFIC)
2 TURN BOTH MODE SELECTOR SWITCHES TO NORMAL
3 DEPRESS AUTO PERMISSIVE "ON" PUSH BUTTON
4 CHECK FOR PEDESTRIANS
5 TURN TRAFFIC CONTROL SWITCHES TO "AUTO" POSITION (NEAR & FAR)
5 DEPRESS "START OPERATIONS" PUSH BUTTON
6 MANUALLY LOWER FAR SIDE ON-COMING GATE # 1 (LEFT SIDE OF MAIN CONTROL PANEL)
7 MANUALLY LOWER NEAR SIDE ON-COMING GATE #1 (REAR CONTROL PANEL)
8 MANUALLY LOWER NEAR SIDE OFF-GOING GATE #2 (REAR CONTROL PANEL)
9 MANUALLY LOWER FAR SIDE OFF-GOING GATE # 2 (LEFT SIDE OF MAIN CONTROL PANEL)
10 CHECK AGAIN FOR PEDESTRIANS
11 DEPRESS "OPEN LEAF" PUSH BUTTON (HORN SOUNDS AUTOMATICALLY)
12 SPANS ACCELERATE TO FAST SPEED AFTER 7.5 DEGREES
13 SPANS STOP AT FULL OPEN (68 DEGREES) & BRAKES SET (WHITE LIGHTS ILLUMINATE)

BRIDGE CLOSING

1 CONFIRM VESSEL HAS CLEARED (INCLUDING TAG VESSELS)
2 DEPRESS "CLOSE LEAF" PUSH BUTTON (HORN SOUNDS AUTOMATICALLY)
3 NEAR SIDE SPAN ACCELERATES THEN FAR SIDE UNTIL NEAR CLOSED
4 SPANS WILL FULLY CLOSE AUTOMATICALLY (WHITE "FULLY CLOSED POSITION" LIGHTS)
5 ALL LOCKS SET AND GATES OPEN AUTOMATICALLY
6 CONTACT 911 (BRIDGE NOW RE-OPENED TO VEHICULAR TRAFFIC)
7 LOG ENTRY

E-1. Normal Operating Instructions (07-18-2013)



LAFAYETTE BRIDGE

QUICK REFERENCE GUIDE:

MANUAL OPERATIONS

BRIDGE OPENING

1 CONTACT 911 (BRIDGE OPENING - CLOSED TO VEHICULAR TRAFFIC)
2 SET BOTH NEAR & FAR MODE SELECTORS SWITCHES TO MANUAL
3 CENTER LOCKING SWITCH MUST BE IN "AUTOMATIC" POSITION
4 SET TRAFFIC CONTROL SWITCHES TO MANUAL (BOTH FAR & NEAR SIDE)
5 MANUALLY LOWER ON-COMING GATES (#1) EAST BOUND THEN WEST BOUND
6 MANUALLY LOWER OFF-GOING GATES (#2) WEST BOUND THEN EAST BOUND
7 RELEASE FAR SIDE TAILOCKS (HOLD SWITCHES UNTIL GREEN LIGHT ILLUMINATES)
8 RELEASE NEAR SIDE TAILOCKS (HOLD SWITCHES UNTIL GREEN LIGHT ILLUMINATES)
9 CHECK FOR PEDESTRIANS
10 DEPRESS "DUPLEX HORN" BUTTON (ONE LONG & ONE SHORT BLAST)
11 TURN LEAF MANUAL CONTROLS TO RAISE DIRECTION (SLOW UNTIL 10 DEGREES THEN FAST)
12 LEAVES STOP AUTOMATICALLY AT FULL OPEN (TURN LEAF CONTROLS TO OFF)

BRIDGE CLOSING

1 CONFIRM VESSEL HAS CLEARED (INCLUDING TAG VESSELS)
2 DEPRESS "DUPLEX HORN" BUTTON (ONE SHORT BLAST)
3 TURN NEAR LEAF MANUAL CONTROL TO LOWER DIRECTION (F)
4 TURN FAR LEAF MANUAL CONTROL TO LOWER DIRECTION ONCE NEAR SIDE IS AT 65 DEGREES (F
5 SLOW BOTH LEAVES ONCE AT 10 DEGREES (BOTH STOP AUTOMATICALLY AT 3.5 DEGREES)
6 TURN LEAF CONTROL SWITCHES TO OFF POSITION
7 TURN "CENTER LOCKING" SWITCH TO MANUAL POSITION
8 LOWER FAR SIDE LEAF FIRST (1 SECOND) THEN LOWER NEAR SIDE LEAF (FULLY CLOSED LIGHT)
9 TURN LEAF CONTROL SWITCHES TO OFF POSITION
10 TURN "CENTER LOCKING" SWITCH TO AUTO POSITION
11 LOCK FAR SIDE TAILOCKS (RED LIGHTS WILL ILLUMINATE)
12 LOCK NEAR SIDE TAILOCKS (RED LIGHTS WILL ILLUMINATE)
13 DEPRESS "RAISE ALL GATES" SWITCH" (HOLD DOWN UNTIL ALL GATES ARE RAISED)
14 TURN BOTH NEAR AND FAR "TRAFFIC CONTROL" SWITCHES TO AUTO POSITION
15 DEPRESS "CLOSE LEAF" BUTTON
16 DEPRESS AUTO PERMISSIVE THEN AUTO RESET
17 CONTACT 911 (BRIDGE NOW RE-OPENED TO VEHICULAR TRAFFIC)
18 LOG ENTRY

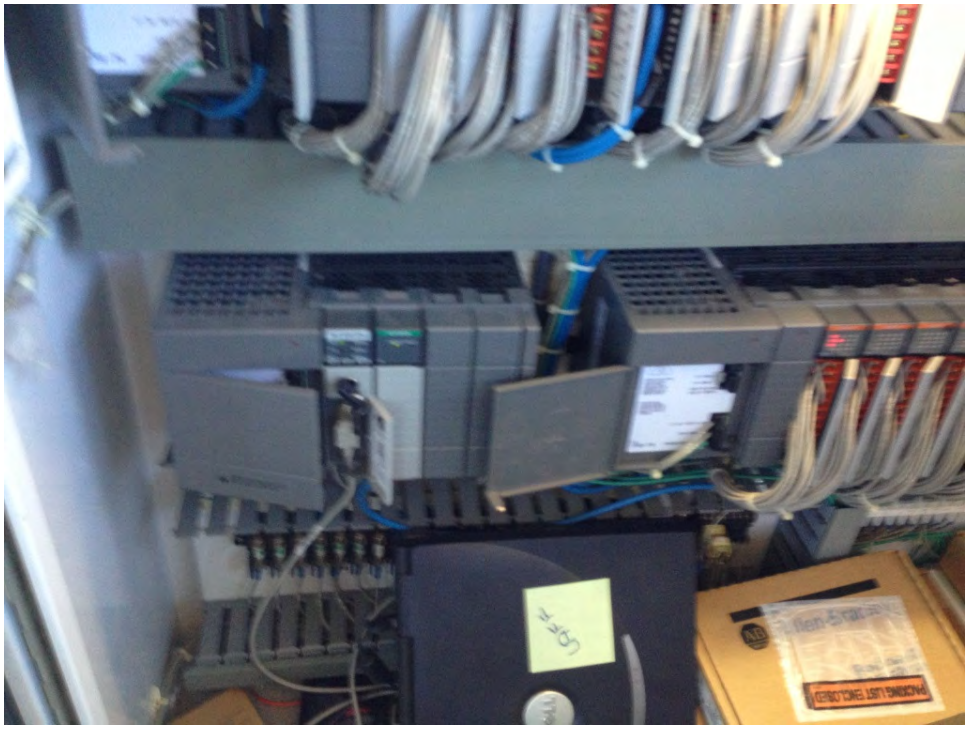
E-2. Manual Operating Instructions (07-18-2013)

E-3. Operator House – Left Side of Control Console (07-18-2013)

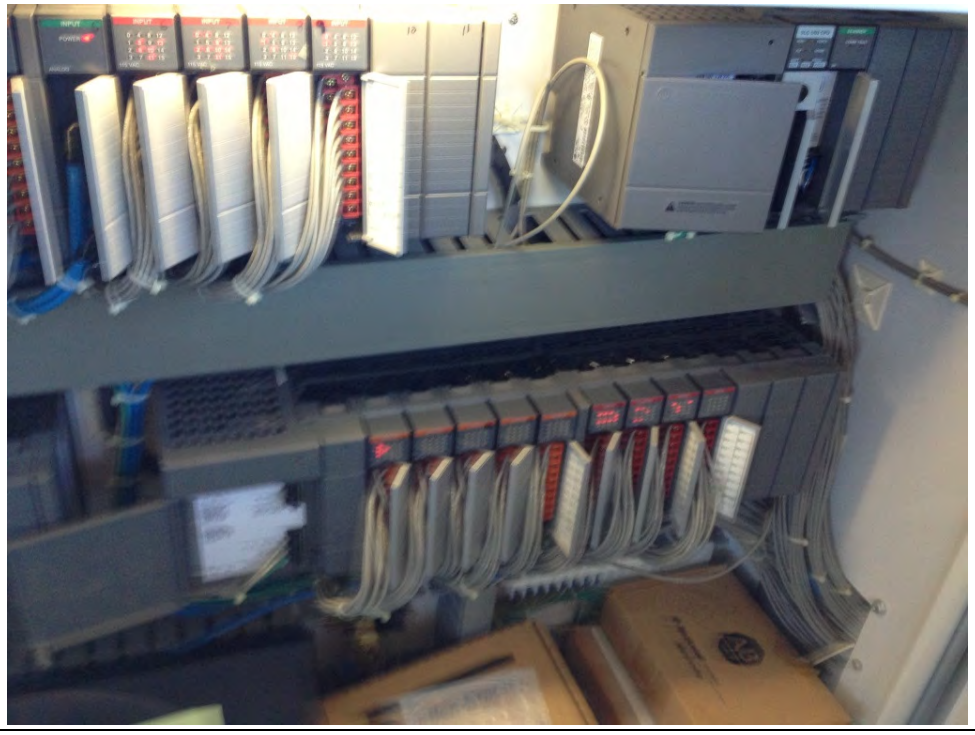
E-4. Operator House – Right Side of Control Console (07-18-2013)

E-5. Operator House – PLC Cabinet (07-18-2013)

E-6. Operator House – PLC Racks (07-18-2013)



E-7. Operator House – PLC Processor (07-18-2013)



E-8. Operator House – PLC I/O Rack (07-18-2013)

E-9. East Machinery Room – DC Main Drive Motor (07-18-2013)

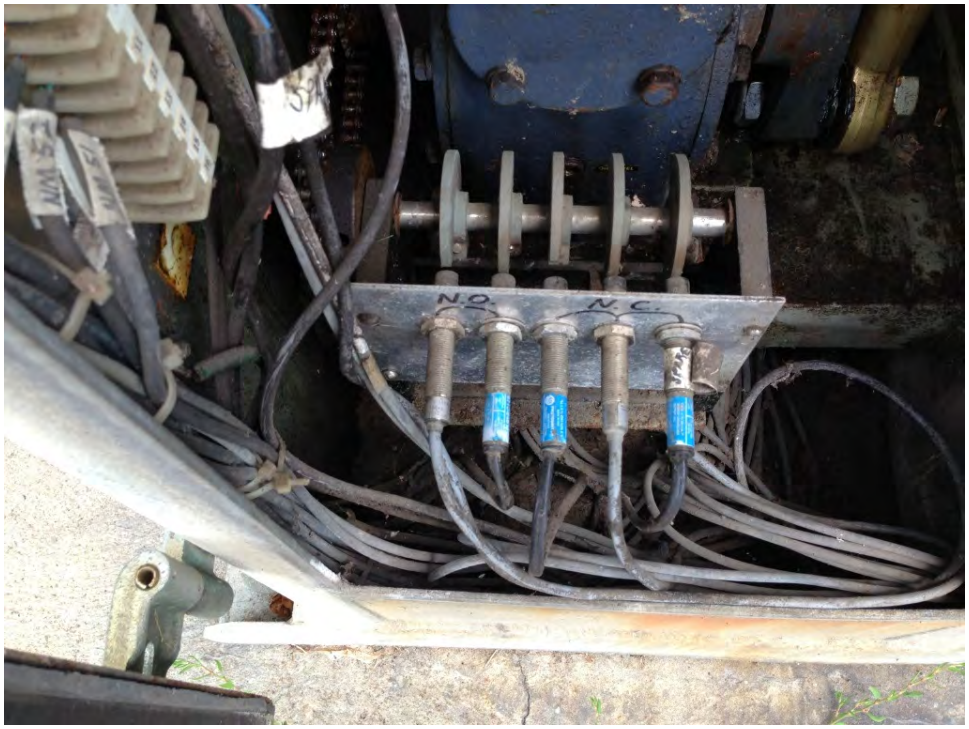
E-10. East Abutment – Traffic Signals and Near Approach (07-18-2013)

E-11. East Abutment – Near Approach and Signage (07-18-2013)

E-12. East Abutment – Traffic Gate (07-18-2013)

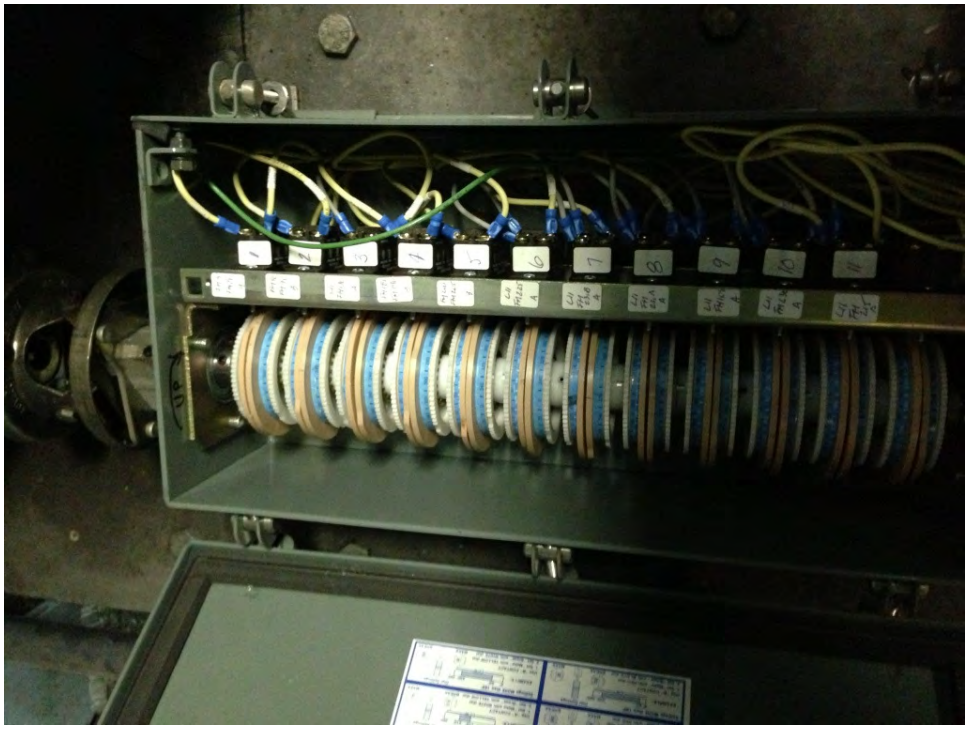
E-13. East Abutment – Electrical Pedestal and Gas Meter (07-18-2013)

E-14. East Abutment – Electrical Manhole (07-18-2013)



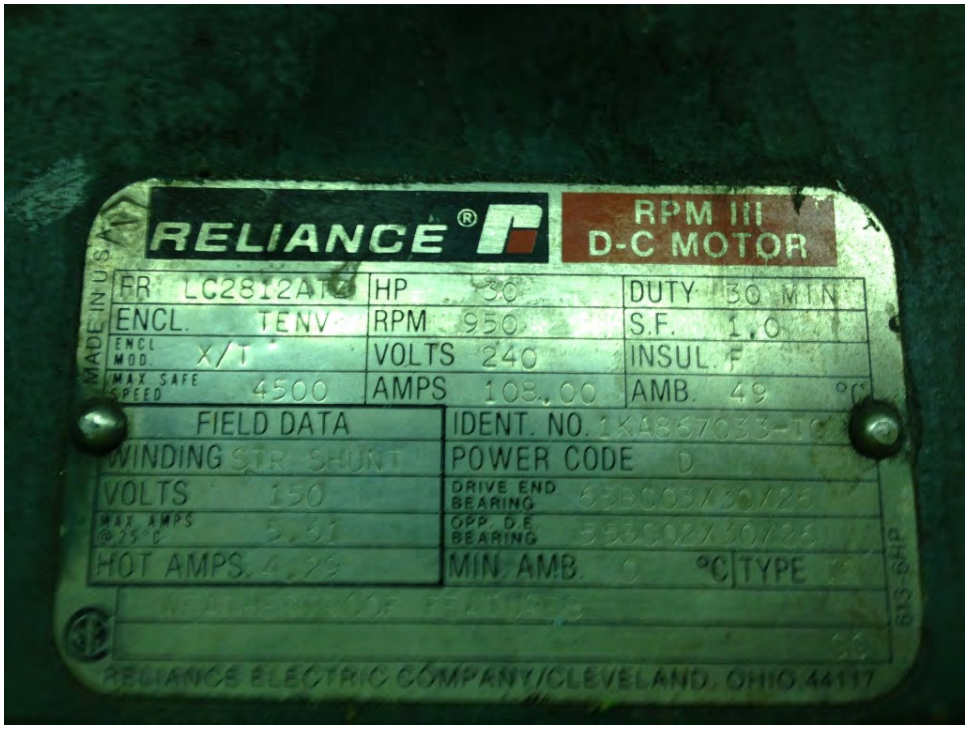
E-15. Traffic Gate – Proximity Limit Switches (07-18-2013)

E-16. Traffic Gate – Corrosion on housing (07-18-2013)



E-17. Machinery Room – Span Position Cam Limit (07-18-2013)

E-18. Machinery Room – Resolver and Gear Reduction for Cam Limit and Resolver (07-18-2013)

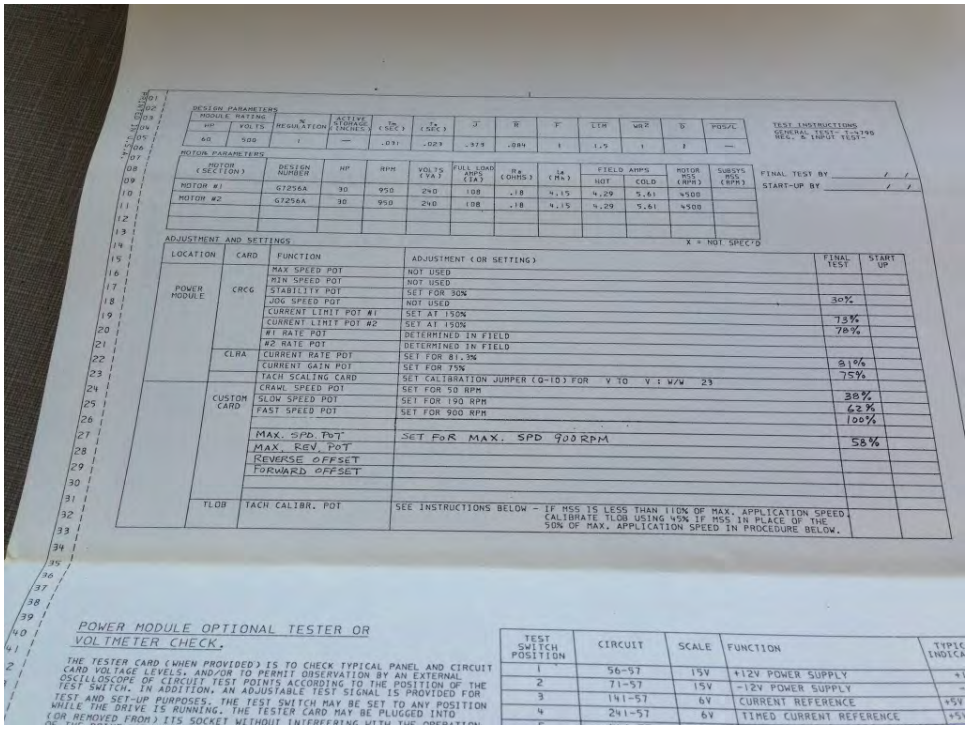


E-19. Machinery Room – Motor Nameplate (07-18-2013)

E-20. Machinery Room – Corrosion on Disconnects (07-18-2013)

E-21. Machinery Room – Motor and Brakes (07-18-2013)

E-22. Machinery Room – Brakes and Primary Speed Reducer (07-18-2013)



DESIGN PARAMETERS

MODULE RATING HP	VOLTS	% REGULATION	ACTIVE STORAGE (INCHES)	τ_m (SEC)	τ_e (SEC)	J	R	F	LTR	WR2	D	POSC
60	500	1	—	.031	.029	.379	.084	1	1.5	1	1	—

TEST INSTRUCTIONS
GENERAL TEST- T-3198
REL. & INPUT TEST-

MOTOR PARAMETERS

MOTOR (SECTION)	DESIGN NUMBER	HP	RPM	VOLTS (VA)	FULL LOAD AMPS (IA)	Ra (OHMS)	IA (MA)	FIELD AMPS NOT	FIELD AMPS COLD	MOTOR POS (RPM)	SUBSYS POS (RPM)
MOTOR #1	G7256A	30	950	240	108	.18	4.15	4.29	5.61	4500	
MOTOR #2	G7256A	30	950	240	108	.18	4.15	4.29	5.61	4500	

FINAL TEST BY ____ / /
START-UP BY ____ / /

X = NOT SPEC'D

ADJUSTMENT AND SETTINGS

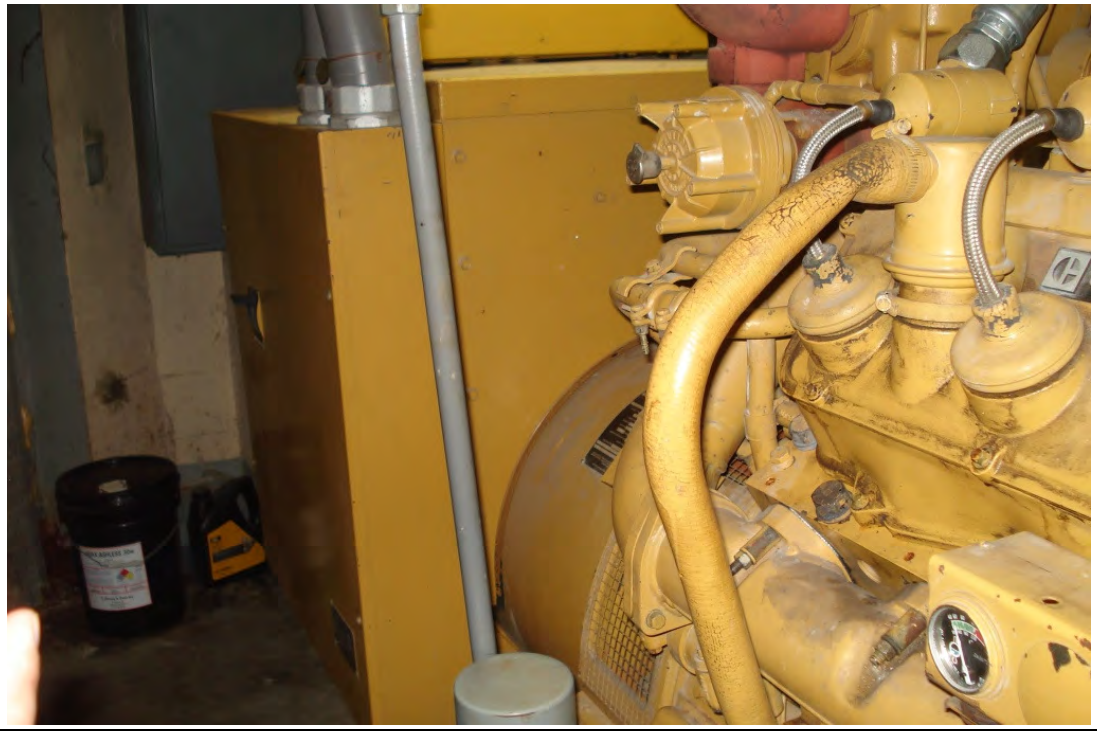
LOCATION	CARD	FUNCTION	ADJUSTMENT (OR SETTING)	FINAL TEST	START UP
POWER MODULE	CRCG	MAX SPEED POT	NOT USED		
		MIN SPEED POT	NOT USED		
		STABILITY POT	SET FOR 30%		
		JOG SPEED POT	NOT USED	30%	
		CURRENT LIMIT POT #1	SET AT 150%		
		CURRENT LIMIT POT #2	SET AT 150%	73%	
		#1 RATE POT	DETERMINED IN FIELD	78%	
		#2 RATE POT	DETERMINED IN FIELD		
	CLRA	CURRENT RATE POT	SET FOR 81.3%		
		CURRENT GAIN POT	SET FOR 75%	81%	
		TACH SCALING CARD	SET CALIBRATION JUMPER (Q-10) FOR V TO V : W/W 23	75%	
	CUSTOM CARD	CRAWL SPEED POT	SET FOR 50 RPM		
		SLOW SPEED POT	SET FOR 190 RPM	38%	
		FAST SPEED POT	SET FOR 900 RPM	62%	
				100%	
		MAX. SPD. POT	SET FOR MAX. SPD 900 RPM		
		MAX. REV. POT		58%	
		REVERSE OFFSET			
		FORWARD OFFSET			
	TLOB	TACH CALIBR. POT	SEE INSTRUCTIONS BELOW – IF MSS IS LESS THAN 110% OF MAX. APPLICATION SPEED CALIBRATE TLOB USING 45% IF MSS IN PLACE OF THE 50% OF MAX. APPLICATION SPEED IN PROCEDURE BELOW.		

POWER MODULE OPTIONAL TESTER OR VOLTMETER CHECK.

THE TESTER CARD (WHEN PROVIDED) IS TO CHECK TYPICAL PANEL AND CIRCUIT CARD VOLTAGE LEVELS, AND/OR TO PERMIT OBSERVATION BY AN EXTERNAL OSCILLOSCOPE OF CIRCUIT TEST POINTS ACCORDING TO THE POSITION OF THE TEST SWITCH. IN ADDITION, AN ADJUSTABLE TEST SIGNAL IS PROVIDED FOR TEST AND SET-UP PURPOSES. THE TEST SWITCH MAY BE SET TO ANY POSITION WHILE THE DRIVE IS RUNNING. THE TESTER CARD MAY BE PLUGGED INTO (OR REMOVED FROM) ITS SOCKET WITHOUT INTERFERING WITH THE OPERATION.

TEST SWITCH POSITION	CIRCUIT	SCALE	FUNCTION	TYPIC INDICA
1	56-57	15V	+12V POWER SUPPLY	+1
2	71-57	15V	-12V POWER SUPPLY	—
3	141-57	6V	CURRENT REFERENCE	+5V
4	241-57	6V	TIMED CURRENT REFERENCE	+5

E-23. Operator House – DC Drive OEM (07-18-2013)



E-24. Generator Room – Generator (07-18-2013)

E-25. Span Position Limit (07-18-2013)

E-26. Counterweight Pit – Droop Cables (07-18-2013)

Appendix F – Finite Element Analysis

A non-linear finite element analysis using LUSAS software (v. 14.7-9) was performed to evaluate performance of the proposed retrofit assembly, including the 6-inch thick tread plate, flange and web weldments and bolts connecting the tread plate to the flanges. The following are the primary assumptions of the analysis:

a) Solid linear (small deformation) 3D elements were used to model all assembly components. All components used steel linear material properties with Young's modulus of 29,000 ksi (kips per square inch) and Poisson's ratio of 0.3.

b) A pie-shaped section of the main girder web, the split flange-web weldments, and the tread assembly was analyzed to evaluate performance of a typical intermediate location. See Fig. 1 for geometric details.

c) The following boundary conditions were assumed:

- Web of the main girder was assumed fixed at both sides and top boundaries.
- Flanges of main girder and tread plate were assumed free to expand.
- Contact surfaces between flanges and tread plate (circumferential surface) were assumed as "frictionless slideline" (LUSAS term for contact modeling). Additional analysis investigating effects of contact with friction coefficient ranging between 0.3 and 0.6 did not show appreciable differences in stress levels.
- Contact surfaces between the two flange plates of the split flange-web weldments (vertical plane) were assumed as frictionless slideline.
- Contact surfaces between bolt shanks, tread plates, and flanges of split flange-web weldments were assumed as frictionless slideline.
- Additional analysis was performed to envelope bolt shear behavior by assuming tied surfaces between bolt shanks, tread plates, and flanges of split flange-web weldments.
- Contact surfaces between bolt heads and flange and web weldment flanges, or tread plate were assumed as tied surfaces.

d) The following loading was assumed:

- Dead load of 977 kips was assumed to be placed as a line load at three different locations to model three consecutive bascule leaf positions, spaced, 6 inches apart from each other, as measured along the flange-to-tread contact line.
- Bolt preload of 75% of proof load, i.e. 63.75 ksi, was modeled using equivalent uniform temperature difference load. Due to small gap modeled between half-flanges and tread plate and elastic deformations, the final value of temperature difference had

to be obtained using an iterative approach. To account for relaxation stress losses, losses due to applied dead load, and to address model convergence issues, slightly smaller bolt stress values were used than those based on proof load. The average final value of the tensile stress in a bolt was 55 ksi for longer bolts and 48 ksi for shorter bolts.

e) Split flange-web weldment side plates were modeled as integral with the existing main girder web plate to simplify modeling. This approach was used because the primary focus of the investigation was on the flanges, tread plates and connecting bolts, including their interface. The webs and web connections were not of concern. Since the side plates would be bolted to the existing web plate using multiple rows of stitching bolts, they were considered undivided. However, the new half-flanges were considered to be connected only to side web plates and not connected directly to the existing main girder web plate.

The maximum compressive stress in the tread plate bottom surface under loading was found to be 50.5 ksi, localized at knife edge loading locations (see Figure F-3). Discounting the effects of local stress spikes due to line loading (actual contact loading has a small area along the tread circumference) and modeling mesh limitations to a more appropriate average contact area, the maximum stress level appears to be approximately 40 ksi. Radial deflections of less than 0.025 inches can be partially attributed to the modeled small (0.01 in) gap between surfaces of flanges and tread plate, as corresponding deflection at bottom of flanges does not exceed 0.01 inches (see Figure F-7). Compression at the top surface of the tread plate and bottom of flanges does not exceed 15 ksi. The web plate near the bottom flange experienced compressive stress under 17 ksi (see Figure F-6).

Another item of investigation was the tensile stress range in the connecting tread plate bolts during bridge openings. Figure F-8 provides a graphical representation of the axial stress envelop for a series of four of the inboard rows of bolts on each side of the girder web. It shows the maximum differences between axial stresses produced by loads at each of three locations, generated by the aforementioned dead loads placed at three locations. The tensile stress range in the bolts is below 12 ksi. It is worth noting that the maximum stress range value is not uniform throughout the bolt shank cross section. This is an indication of flexure being induced into the bolts. The maximum absolute value of shear in bolt cross sectional planes from three analyzed loading positions was 22.6 ksi near the bolt heads. On the other hand, an additional model using tied surface condition between bolt shank and flanges/tread plate (to envelope shear behavior in bolts) produced a maximum of 16.2 ksi shear stress near the flanges/tread interface surface (see Figures F-9 & F-10).

In summary, the finite element analysis (FEA) confirms that the proposed concept with a 6 inch thick tread plate is adequate to distribute the loads to sufficiently limit deformations in the assembly such that the stress range in the connecting bolts is well below their fatigue limit.

Furthermore, the distribution of loads, results in compressive and contact stresses that are within the design parameters. It should be noted that this analysis is limited to a snap shot of one location in the assembly. If this concept is taken forward into design, additional analysis should be performed to confirm the adequacy of the bolts connecting the Split flange-web weldments to the main girder web, the stiffener sizes, and details (stiffeners, bolts, etc.) at the ends of the tread plate.

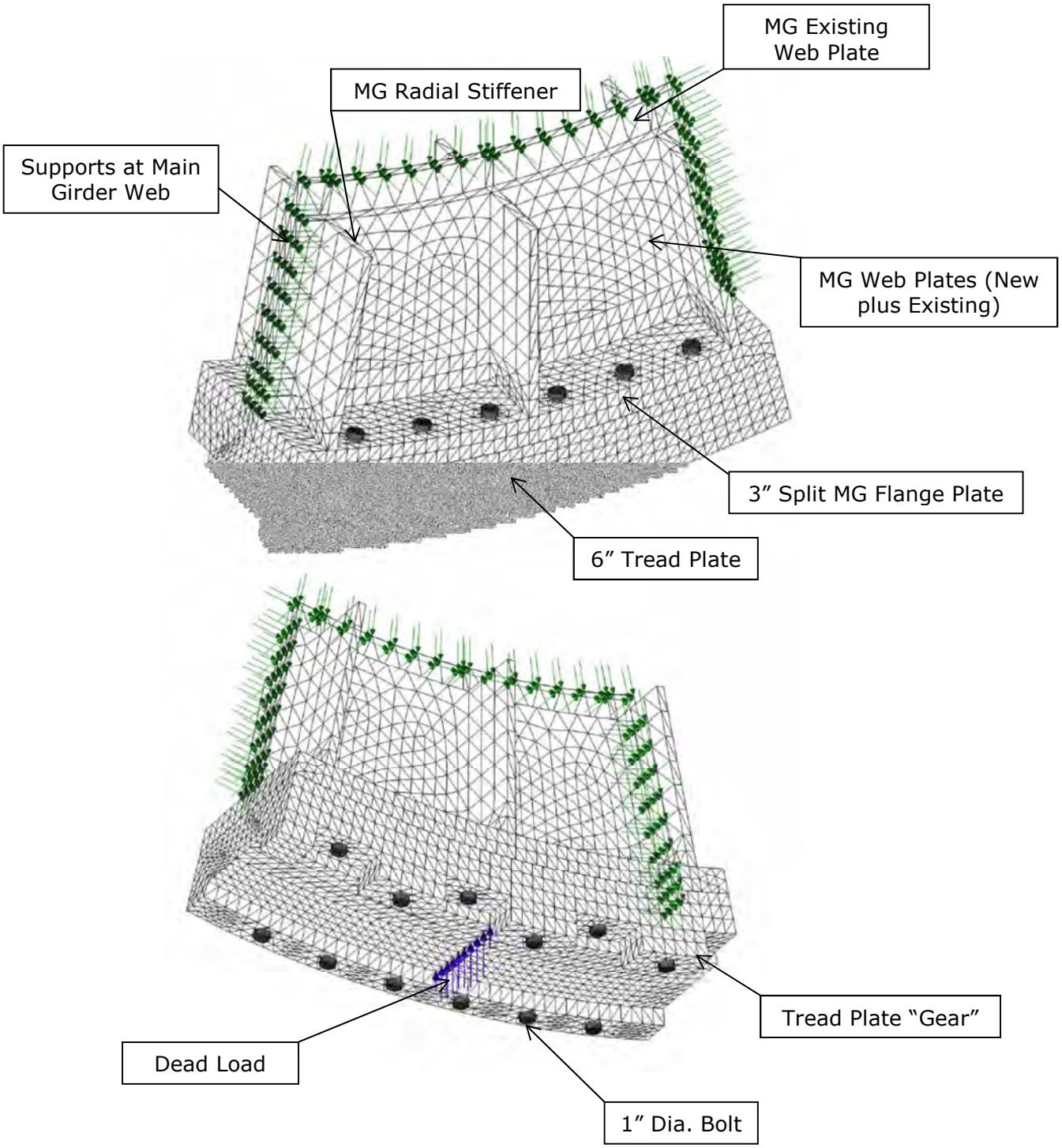


Figure F-1: Isometric Views of FEA Model of Partial Main Girder and Tread Plate

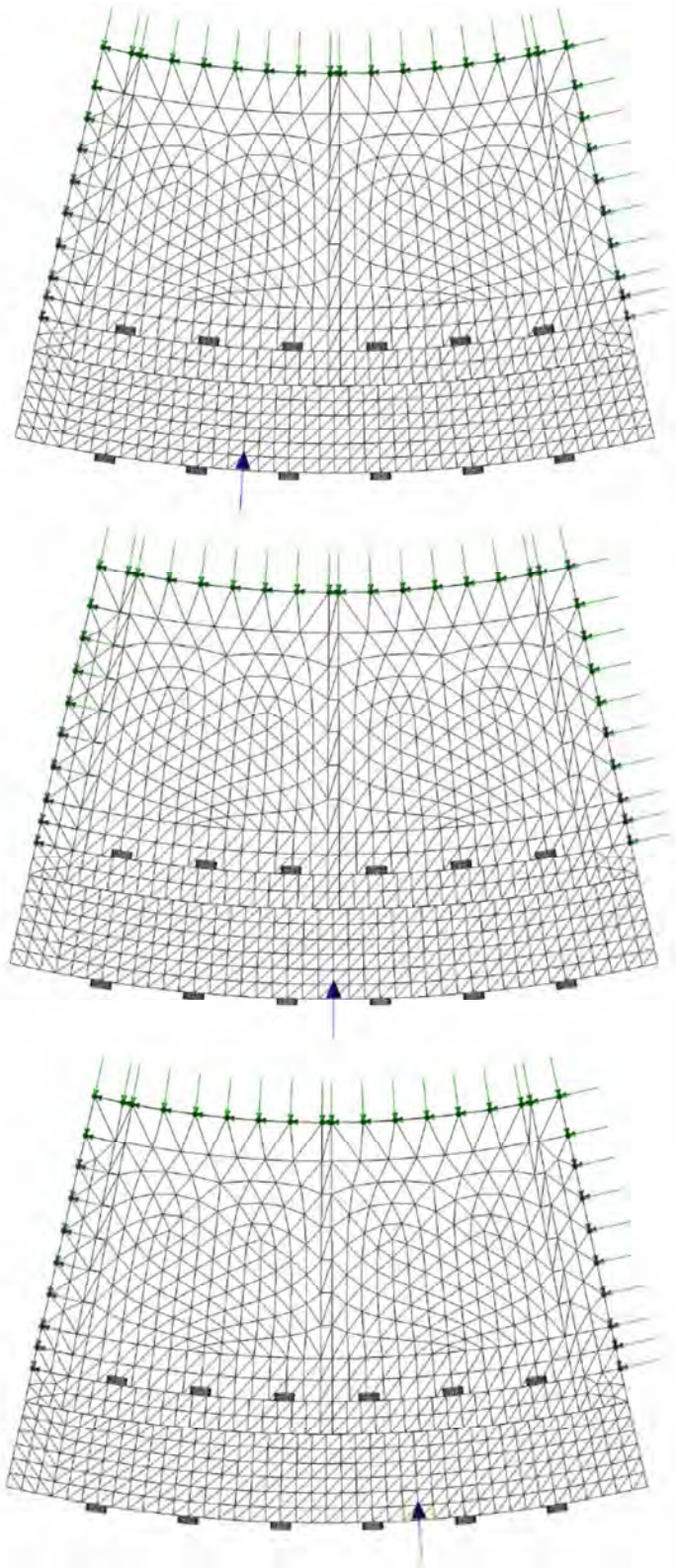


Figure F-2: Loading – Dead Load at Three Subsequent Discrete Bridge Opening Positions

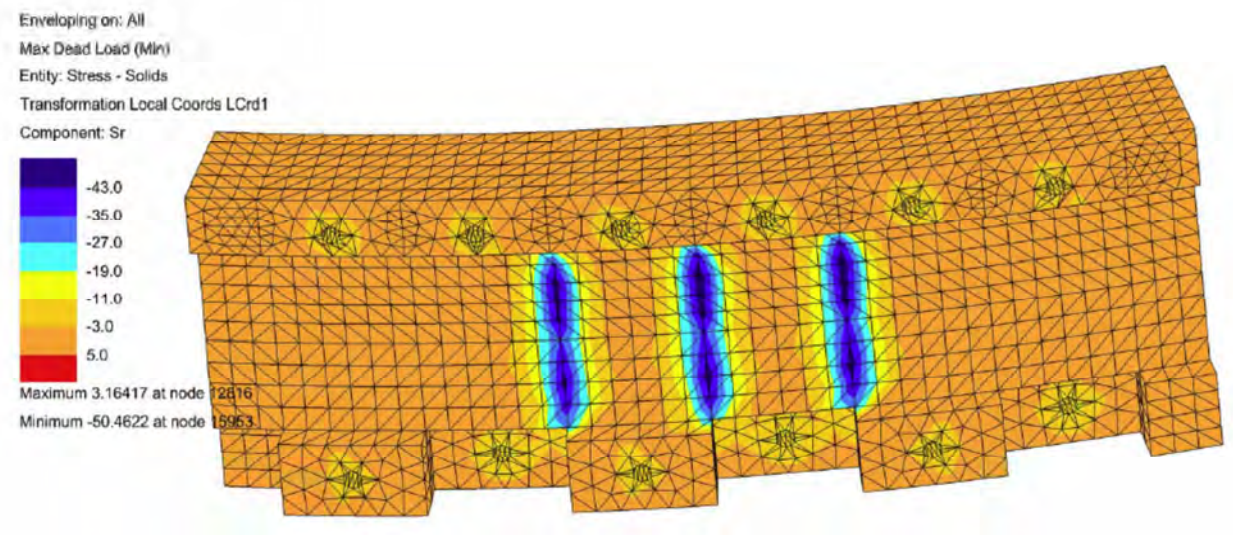


Figure F-3: Compressive Stresses at Bottom Surface of Tread Plate (Three Load Envelope)

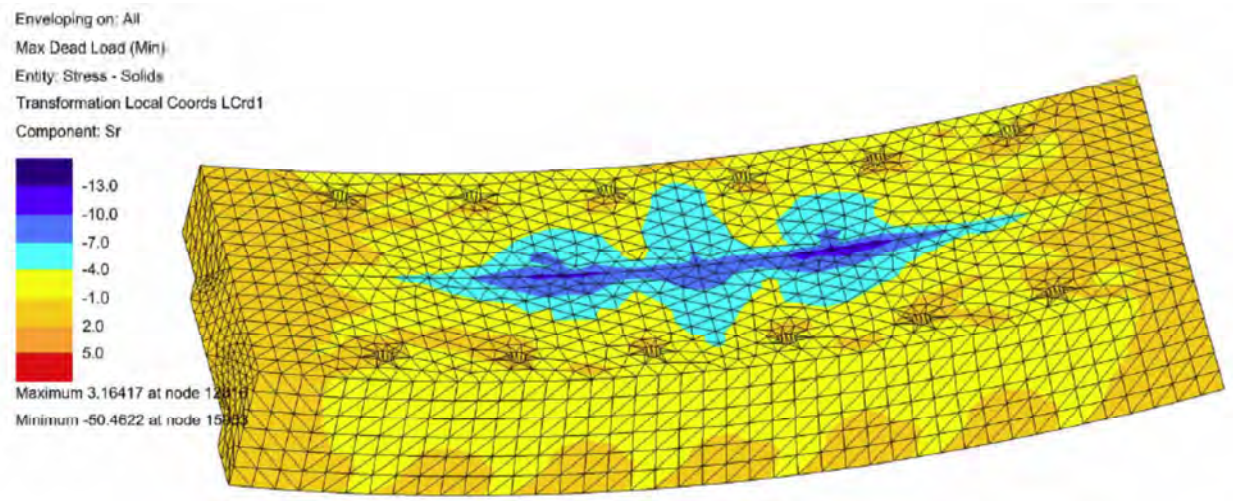


Figure F-4: Compressive Stresses at Top Surface of Tread Plate (Three Load Envelope)

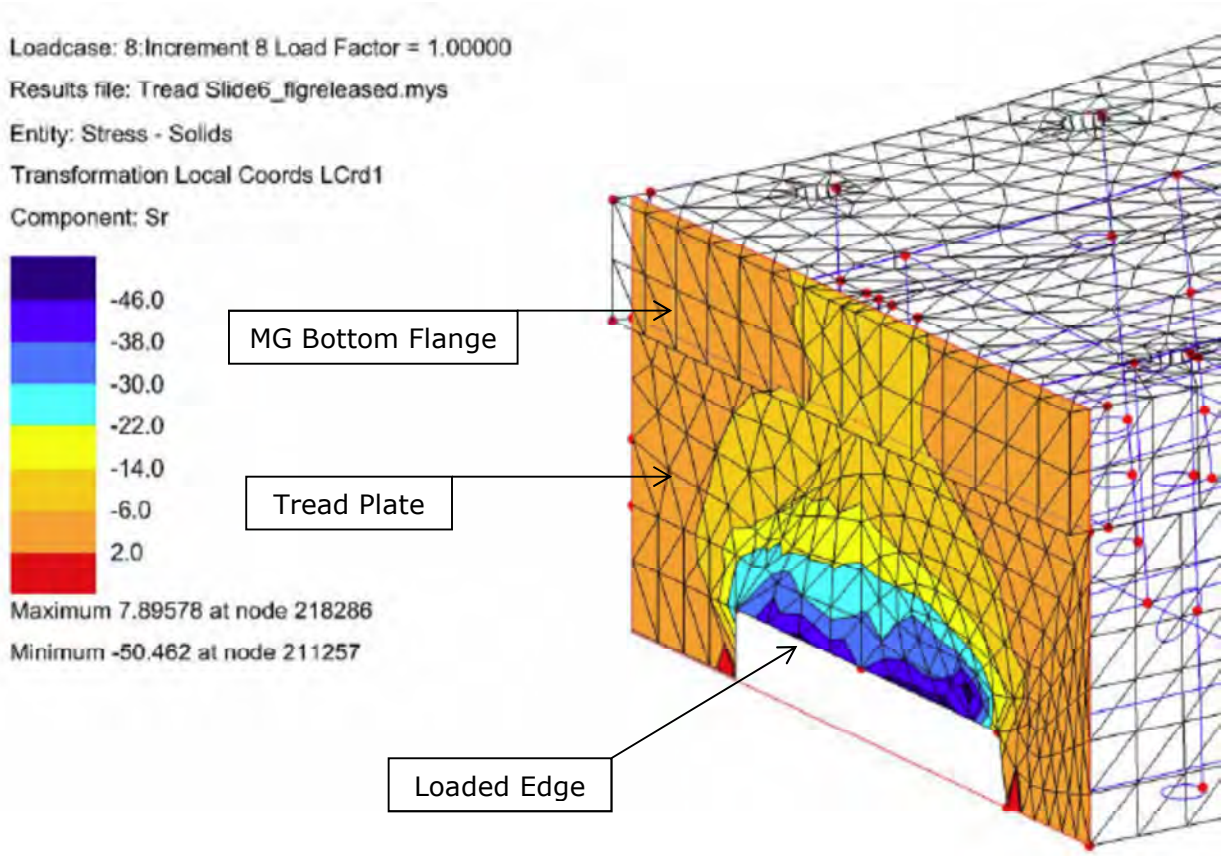


Figure F-5: Cross Section of Radial Stress in Tread and Flange Plates at Location of Dead Load.

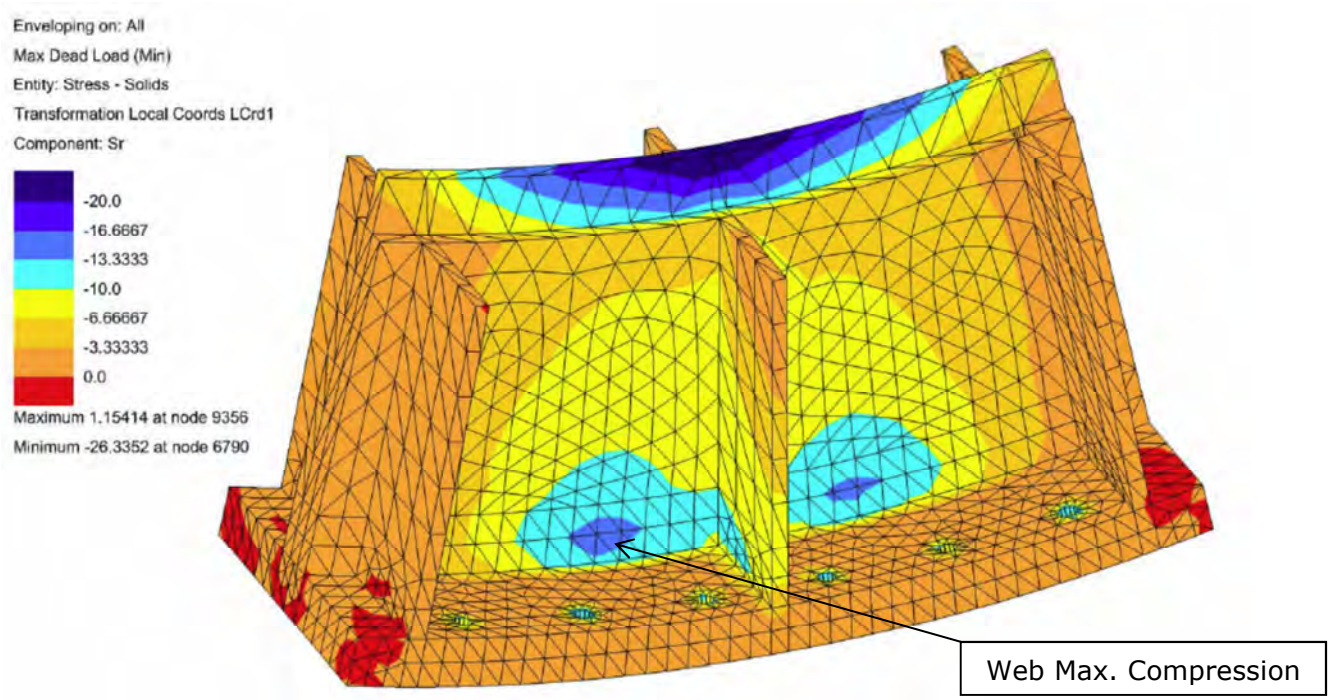


Figure F-6: Compressive Stresses at Main Girder Components (Three Load Envelope)

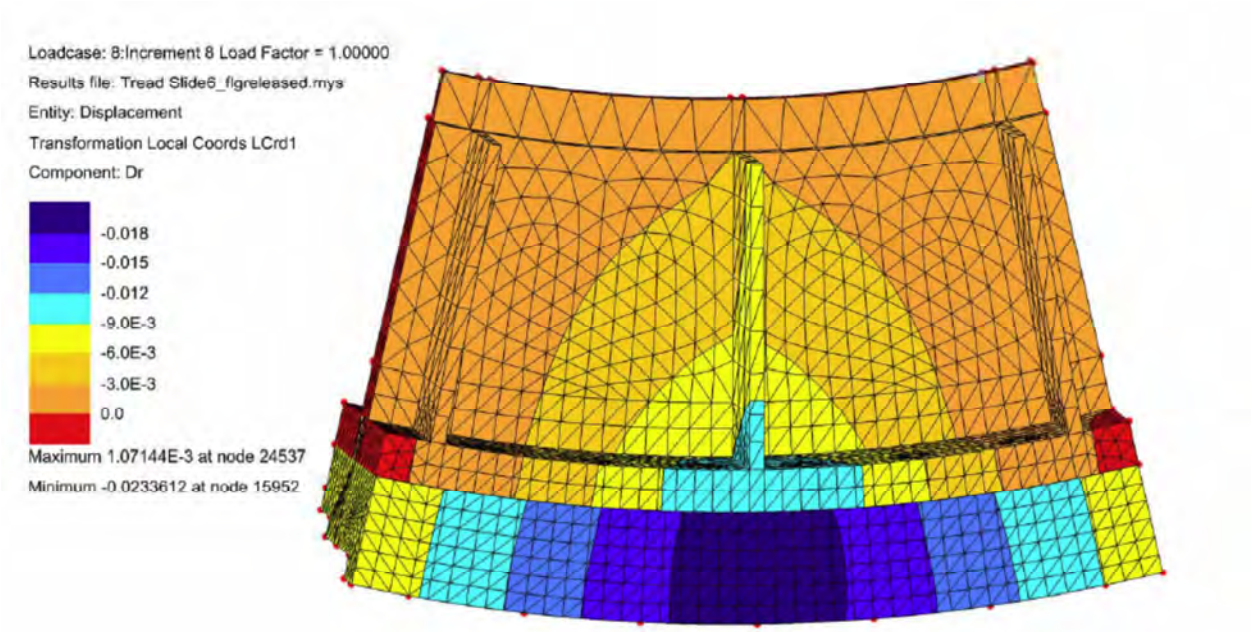


Figure F-7: Radial Deflection Under Load Placed Below Center Stiffener (in).

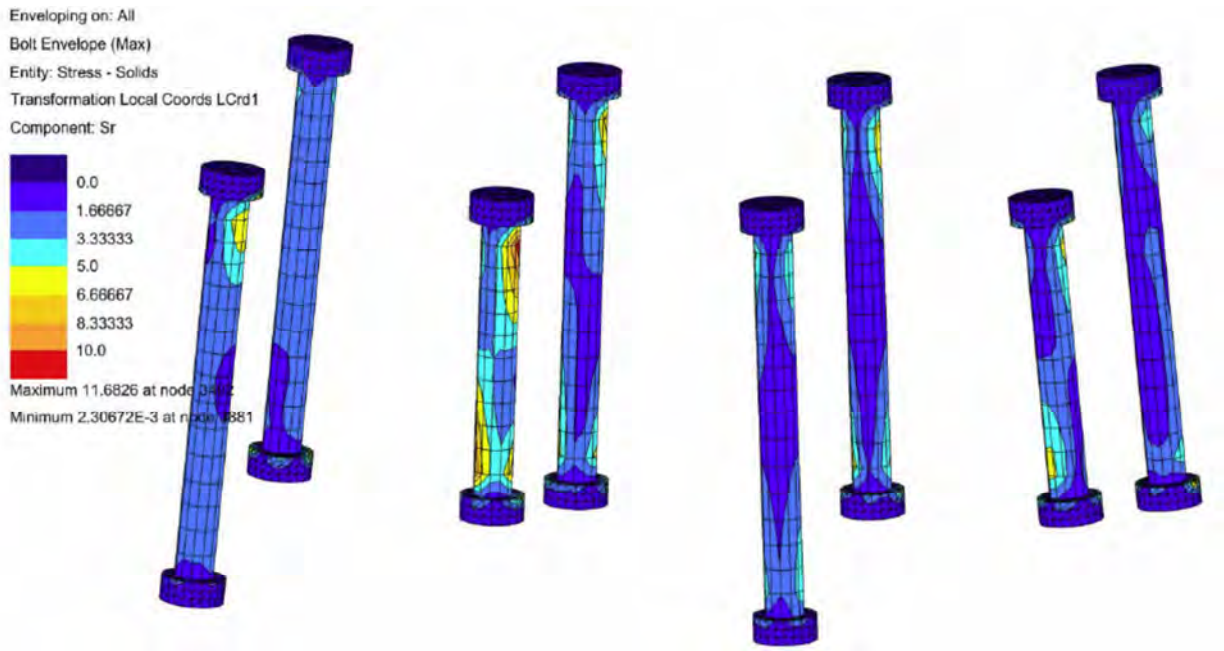


Figure F-8: Maximum Tensile Stress Range for Bolts (Four Inboard Bolt Rows Shown)

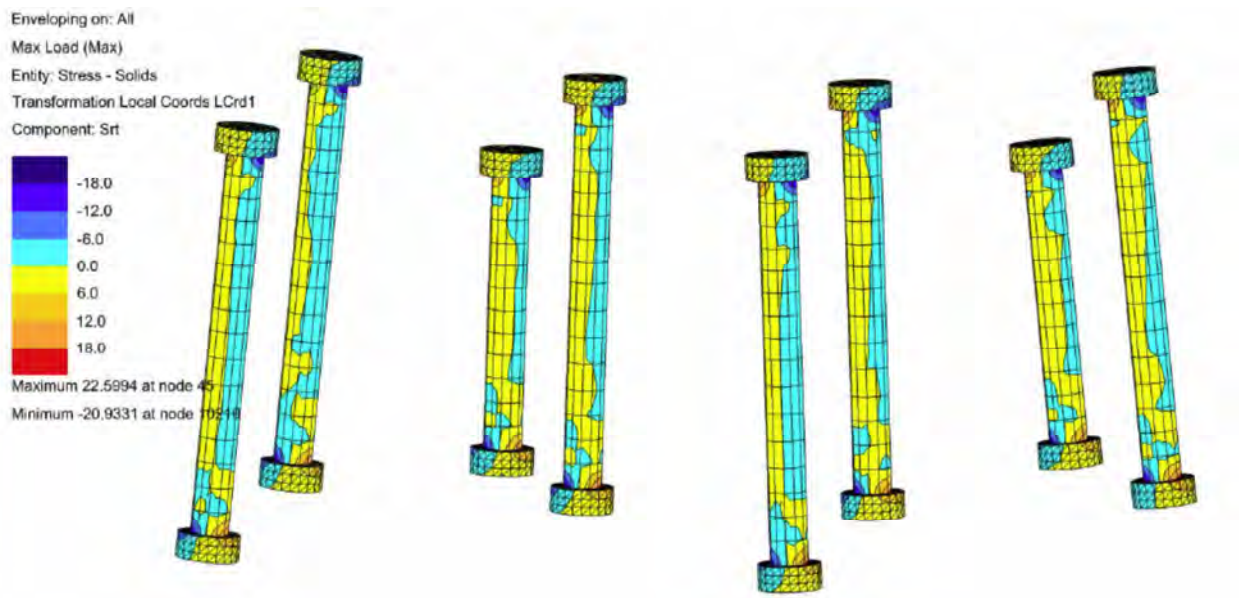


Figure F-9: Maximum Shear Stress Bolts (Four Inboard Bolt Rows Shown).

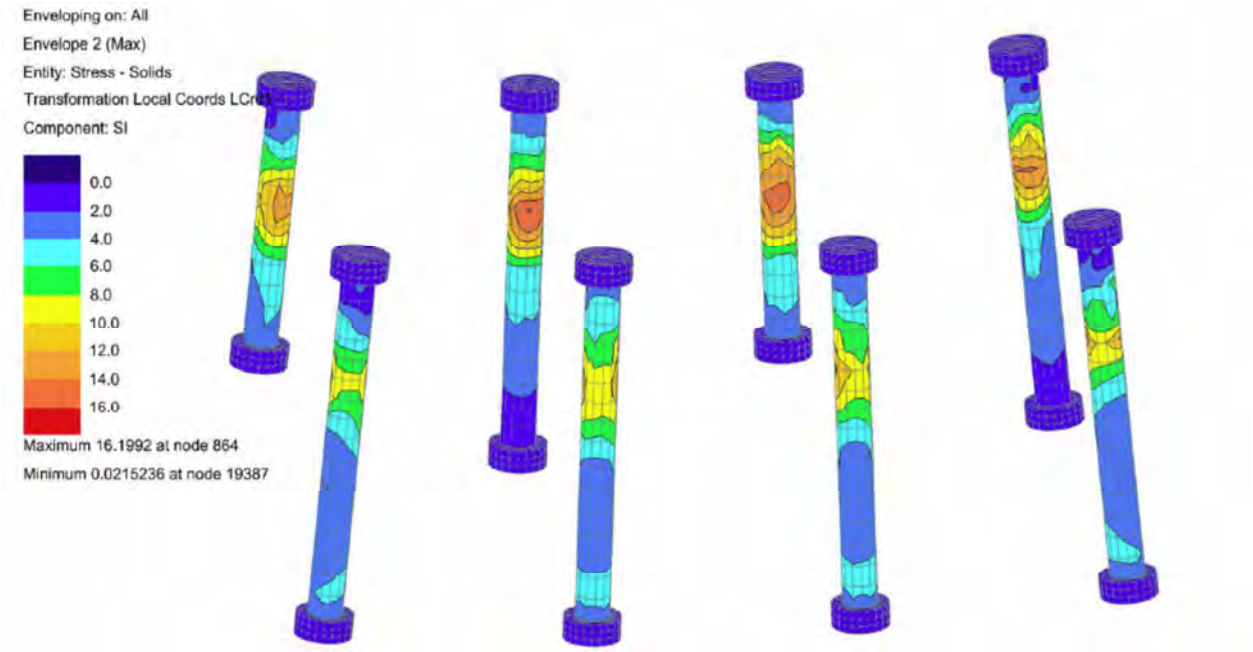


Figure F-10: Maximum Shear Stress Bolts – Model with Bolt Shank Tied to Flanges and Tread Plate (Four Inboard Bolt Rows Shown).

Appendix G – Concrete Testing

G-1 Concrete Core Reports (SME)

G-2 Petrographic Report (CTL)

TRANSMITTAL

Date: 10/03/2013

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Plymouth, MI 48170-2584
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Fax: (734) 454-0629

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☐ 3301 Tech Circle Drive
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Shelby Twp., MI 48315-3122
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Fax: (317) 876-0300

☐ 415 Tomahawk Drive
Maumee, OH 43537-1633
Phone: (419) 897-0409
Fax: (419) 897-0429

Re: **Project:** LAFAYETTE BRIDGE OVER SAGINAW RIVER
Location: BAY CITY, MI
SME Project No: GQ68071

Remarks:

We are transmitting herewith 1 copies of:

- **Report of Concrete Cores:** 1-4

Distribution:

Very truly yours,
SOIL AND MATERIALS ENGINEERS, INC.

JOSEPH L. NOYKOS, PE

kl

Report Of Concrete Cores

PROJECT: LAFAYETTE BRIDGE OVER SAGINAW RIVER
LOCATION: BAY CITY, MI
ARCHITECT/ENGINEER: URS Corporation
CONSTRUCTION MANAGER:
CONTRACTOR:

SME JOB NO: GQ68071
REPORT NO: 1
DATE: 08/23/13

CORE NO.	LOCATION	DIAMETER	DRILLED LENGTH	LENGTH BEFORE CAPPING	LENGTH AFTER CAPPING	L/D FACTOR	AREA SQ. IN.	TOTAL LOAD	PSI
1A	9' S of NE corner of pit, 2' W of E wall	3 3/4"	13"	5 9/16"	6 1/16"	1.62	11.04	102,500	9280 / 9000
1B	19.5' S of NE corner of pit, 3' W of E wall	3 3/4"	6 1/4"	4 3/4"	5 1/8"	1.37	11.04	85,500	7740 / 7310
*1C	5'4" W of SE corner of pit, 2'8" N of S wall	3 3/4"	8"						
1D	10' S of NW corner of pit, 5' E of W wall	3 3/4"	13 1/2"	5 3/4"	6 1/8"	1.63	11.04	100,000	9060 / 8790

CORE NO.	DATE PLACED	DATE TESTED	AGE AT TEST	DIRECTION OF APPLIED LOAD	TESTED		CORE CUTS			NOMINAL MAX SIZE OF AGG
					MOIST	DRY	ONE END	BOTH ENDS	CUBED	

REMARKS: EAST PIT FLOOR CORES
* Denotes specimens submitted for petrographic analysis.

REPORTED BY: DUSTIN KERN
kl - 583654

REVIEWED BY: ROBERT C. TOBER

Report Of Concrete Cores

PROJECT: LAFAYETTE BRIDGE OVER SAGINAW RIVER
LOCATION: BAY CITY, MI
ARCHITECT/ENGINEER: URS Corporation
CONSTRUCTION MANAGER:
CONTRACTOR:

SME JOB NO: GQ68071
REPORT NO: 2
DATE: 08/23/13

CORE NO.	LOCATION	DIAMETER	DRILLED LENGTH	LENGTH BEFORE CAPPING	LENGTH AFTER CAPPING	L/D FACTOR	AREA SQ. IN.	TOTAL LOAD	PSI
*1E	S pier, east core, 5'6" W of E edge of pier and 7' above pit floor	3 3/4"	14"						
1F	S pier, west core, 9'4" W of E edge of pier and 6'4" above pit floor	3 3/4"	13 3/4"	7 9/16"	8"	2.13	11.04	54,500	4940 / 4940
1G	N pier, east core, 6'10" W of E ede of pier and 7'9" above pit floor	3 3/4"	14"	7 1/2"	7 3/4"	2.07	11.04	83,000	7520 / 7520
1H	N pier, west core, 9'8" W of E edge of pier and 8' above pit floor	3 3/4"	13 3/4"	7 1/8"	7 1/2"	2.00	11.04	121,000	10,960 / 10,960

CORE NO.	DATE PLACED	DATE TESTED	AGE AT TEST	DIRECTION OF APPLIED LOAD	TESTED		CORE CUTS			NOMINAL MAX SIZE OF AGG
					MOIST	DRY	ONE END	BOTH ENDS	CUBED	

REMARKS: EAST PIT PIER CORES
* Denotes specimens submitted for petrographic analysis.

REPORTED BY: DUSTIN KERN
kl - 583655

REVIEWED BY: ANTHONY B. THOMAS, PE

Report Of Concrete Cores

PROJECT: LAFAYETTE BRIDGE OVER SAGINAW RIVER
LOCATION: BAY CITY, MI
ARCHITECT/ENGINEER: URS Corporation
CONSTRUCTION MANAGER:
CONTRACTOR:

SME JOB NO: GQ68071
REPORT NO: 3
DATE: 08/23/13

CORE NO.	LOCATION	DIAMETER	DRILLED LENGTH	LENGTH BEFORE CAPPING	LENGTH AFTER CAPPING	L/D FACTOR	AREA SQ. IN.	TOTAL LOAD	PSI
2A	S pier, W core, 6' E of W edge of pier and 2'5" above pit floor	3 3/4"	9"	7 3/16"	7 5/8"	2.03	11.04	94,500	8560 / 8560
*2B	S pier, E core, 9'4" E of W edge of pier and 7'5" above pit floor	3 3/4"	8 1/4"						
2C	N pier, W core, 6' E of W edge of pier and 7' above pit floor	3 3/4"	9 3/4"	7"	7 3/8"	1.97	11.04	91,000	7340 / 7260
2D	N pier, east core, 10' E of W edge of pier and 7' above pit floor	3 3/4"	7 1/2"	6 11/16"	7"	1.86	11.04	77,500	7020 / 6940

CORE NO.	DATE PLACED	DATE TESTED	AGE AT TEST	DIRECTION OF APPLIED LOAD	TESTED		CORE CUTS			NOMINAL MAX SIZE OF AGG
					MOIST	DRY	ONE END	BOTH ENDS	CUBED	

REMARKS: WEST PIT PIER
* Denotes specimens submitted for petrographic analysis.

REPORTED BY: DUSTIN KERN
kl - 583656

REVIEWED BY: ROBERT C. TOBER

Report Of Concrete Cores

PROJECT: LAFAYETTE BRIDGE OVER SAGINAW RIVER
LOCATION: BAY CITY, MI
ARCHITECT/ENGINEER: URS Corporation
CONSTRUCTION MANAGER:
CONTRACTOR:

SME JOB NO: GQ68071
REPORT NO: 4
DATE: 08/23/13

CORE NO.	LOCATION	DIAMETER	DRILLED LENGTH	LENGTH BEFORE CAPPING	LENGTH AFTER CAPPING	L/D FACTOR	AREA SQ. IN.	TOTAL LOAD	PSI
2E	5' S of NW corner of pit & 5' above pit floor	3 3/4"	10 1/4"	7 1/16"	7 1/4"	1.93	11.04	88,500	8020 / 7980
*2F	15' S of NW corner of pit & 5' above pit floor	3 3/4"	5"						
2G	12' N of SW corner of pit & 5' above pit floor	3 3/4"	10"	7"	7 3/8"	1.97	11.04	64,500	5840 / 5830
2H	2'5" N of SW corner of pit & 5' above pit floor	3 3/4"	10"	4 15/16"	5 1/4"	1.40	11.04	94,500	7650 / 7120

CORE NO.	DATE PLACED	DATE TESTED	AGE AT TEST	DIRECTION OF APPLIED LOAD	TESTED		CORE CUTS			NOMINAL MAX SIZE OF AGG
					MOIST	DRY	ONE END	BOTH ENDS	CUBED	

REMARKS: WEST PIT WALL CORES
* Denotes specimens submitted for petrograhic analysis.

REPORTED BY: DUSTIN KERN
kl - 583657

REVIEWED BY: ROBERT C. TOBER

Copy No. 1

Report for
Soil and Materials Engineers, Inc.
1501 West Thomas Street, Bay City, Michigan 48706

CTLGroup Project No. 154970

Petrographic Examination of Concrete Cores from Lafayette Bridge Over Saginaw River, Bay City, Michigan

October 2, 2013

Submitted by:
Qiang Li
Jean L. Randolph

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REPORT OF PETROGRAPHIC EXAMINATION

Date: October 2, 2013

CTLGroup Project No.: 154970

Petrographic Examination of Concrete Cores from Lafayette Bridge Over Saginaw River, Bay City, Michigan

Four concrete cores, labeled 2B, 1C, 1E, and 2F (Figs. 1 through 4), were received on September 11, 2013, from Mr. Robert Tober of Soil and Materials Engineers, Inc., Bay City, Michigan.

The following information was reported to CTLGroup by the client: The concrete cores were taken from Lafayette Bridge over Saginaw River in Bay City, Michigan. The structure was placed in circa 1940's. Core 1C was taken vertically from a pit floor of the bridge, and the other cores were taken horizontally from pit walls of the bridge.

Petrographic examination (ASTM C856) was requested to evaluate the general composition and condition of the cores.

FINDINGS AND CONCLUSIONS

Based on petrographic examination, all cores exhibit similar composition. Cores 2B, 1C, and 1E are judged to be in overall good condition. In Core 2F a crack is present through the full depth of the core; excluding this crack, the concrete appears to be in good condition. The paste in all four cores is hard, which is a desirable quality. The concretes are not air-entrained (Fig. 5); however, no evidence of freeze-thaw deterioration was observed. A minor amount of alkali-silica reaction (ASR) has occurred in Cores 1C and 2F, evidenced by the presence of ASR gel (Figs. 6 and 7); however, only a very minor amount of ASR-associated deterioration (a few microcracks) was observed.

The cracks and microcracks in the four cores are summarized as follows:

- Core 2B. No cracks or microcracks were observed (Fig. 8).

- Core 1C. A few short randomly-oriented microcracks are present (Fig. 9). They are judged to be related to the ASR.
- Core 1E. Several microcracks in Core 1E trend perpendicular to the core exterior surface and are present through the length of the core (Fig. 10).
- Core 2F. A full-depth crack is present through the core. The crack narrows with depth in the concrete and passes mainly around aggregate particles (Fig. 11). Minor ASR gel is noted in the crack (Fig. 7).

Depth of paste carbonation from the exterior concrete surface varies from negligible (Core 1E) to 0.5-in. deep (Core 2B). (See Figure 12.)

In Core 1E large irregularly-shaped voids are common in body (Fig. 3c), indicating underconsolidation of the concrete.

Reinforcement bar segments are present in Cores 2B, 1C, and 1E. The rebar in Core 2B is lightly corroded. Still, the rebar in all cores are in good overall condition.

GENERAL DESCRIPTION OF CONCRETE

The cores from both pit walls and the pit floor exhibit similar composition. The concrete is composed of natural gravel coarse aggregate and natural sand fine aggregate, distributed in a non-air-entrained portland cement paste. General concrete properties are summarized in Table 1. Detailed information of each core is provided in the attached data sheets.

TABLE 1 SUMMARY OF GENERAL CONCRETE FEATURES

Concrete Property	Cores from Pit Walls			Core from Pit Floor
	Core 2B	Core 1E	Core 2F	Core 1C
Air-void system	Not air-entrained.	Not air-entrained.	Not air-entrained.	Not air-entrained.
Estimated air content	1 to 2%	3 to 5%	1%	1%
Paste properties:				
Hardness	Hard	Hard	Hard	Hard
Paste-aggregate bond	Moderately tight	Moderately tight	Moderately weak	Moderately tight
Depth of carbonation	12 mm (0.5 in.) from exterior core surface.	Negligible from exterior core surface.	5 mm (0.2 in.) from exterior surface.	1 mm (0.04 in.) from top surface.
Water-cement ratio	Not provided due to the advanced hydration and old age of the concrete.			
Coarse aggregate	Natural gravel composed mainly of limestone, cherty limestone, cherty dolostone, sandstone, quartzite, granite, and other igneous and metamorphic rocks. Darkened rims are present along some aggregate particles.			
Fine aggregate	Natural sand composed mainly of quartz, limestone, quartzite, chert, feldspar, and other minerals and rocks. Darkened rims are present along some aggregate particles.			

METHODS OF TEST

Petrographic examination of the provided cores was performed in accordance with ASTM C856-11, "Standard Practice for Petrographic Examination of Hardened Concrete." The cores were visually inspected and photographed as received. A slice was cut longitudinally from each core and one of the resulting sides of the slice was ground (lapped) to produce a smooth, flat, semi-polished surface. Lapped and freshly broken surfaces of the concrete were examined using a stereomicroscope at magnifications up to 90X.

For thin-section study, a small rectangular block was cut from each core, and one side of each block was lapped to produce a smooth, flat surface. The blocks were cleaned and dried, and the prepared surfaces were mounted on ground glass microscope slides with epoxy resin. After the epoxy hardened, the thickness of the mounted blocks was reduced to approximately 20 μm (0.0008 in.). The resulting thin sections were examined using a polarized-light (petrographic) microscope at magnifications up to 400X to study aggregate and paste mineralogy and microstructure.

Depth and pattern of paste carbonation was determined by application of a pH indicator solution (phenolphthalein) to freshly cut concrete surfaces. The solution imparts a deep magenta stain to high pH, non-carbonated paste. Carbonated paste does not change color.

Qiang Li
Petrography Group

Jean L. Randolph
Senior Petrographer and Group Manager
Petrography Group

QL/JLR

Notes:
1. Results refer specifically to the samples submitted.
2. This report may not be reproduced except in its entirety.
3. The samples will be retained for 30 days, after which they will be discarded unless we hear otherwise from you.

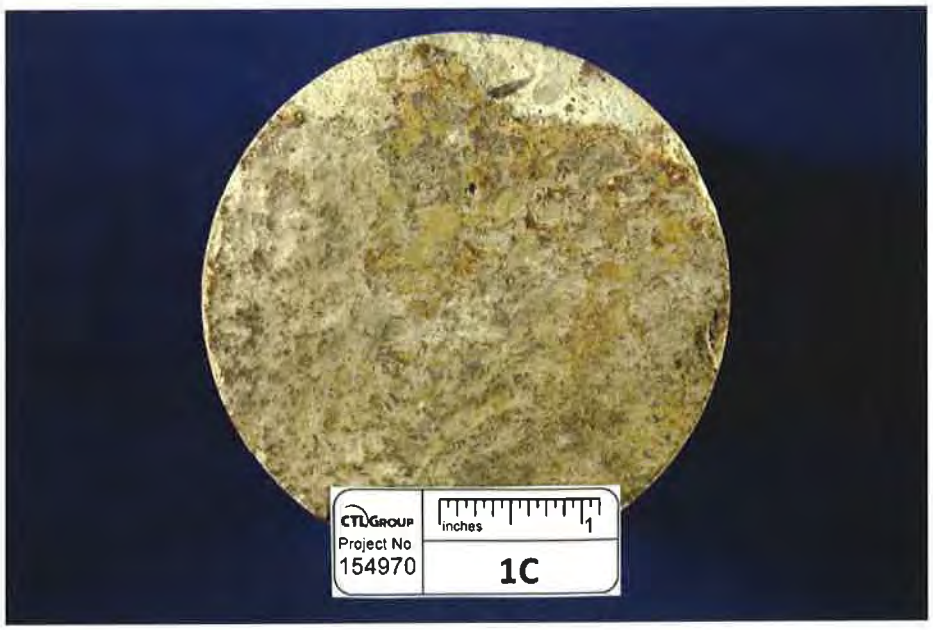
1a. Exterior surface.

1b. Interior surface.

(Continued)

1c. Side view of core. Arrow points to square-shaped steel reinforcing bar. Core top surface at left.

Fig. 1 Core 2B, as received for testing.



2a. Top surface.

2b. Bottom surface. A reinforcement bar is exposed (arrows).

(Continued)

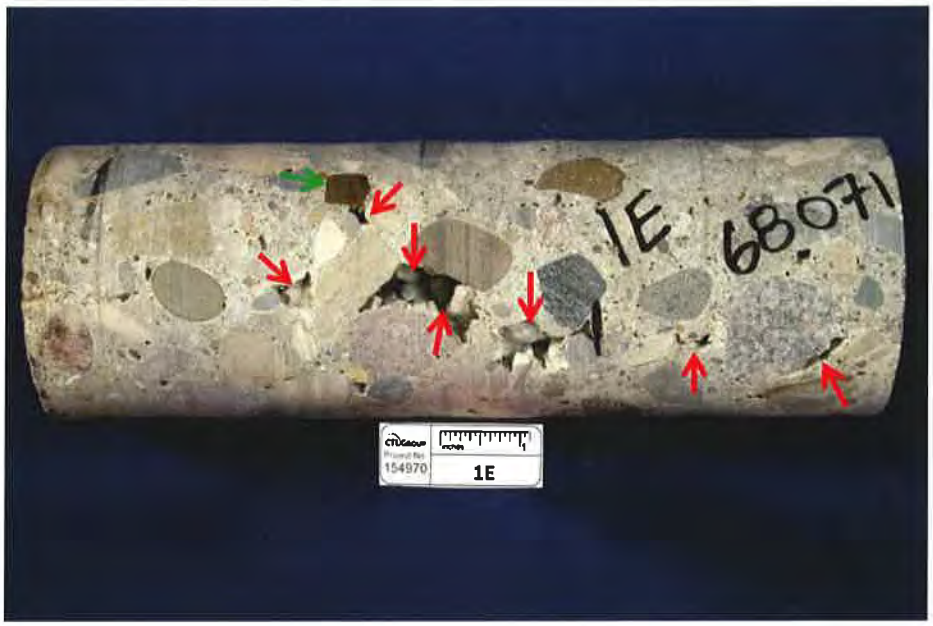
2c. Side view of core. Arrow points to the reinforcement bar. Core top surface at left.

Fig. 2 Core 1C, as received for testing.

3a. Exterior surface.

3b. Interior surface.

(Continued)



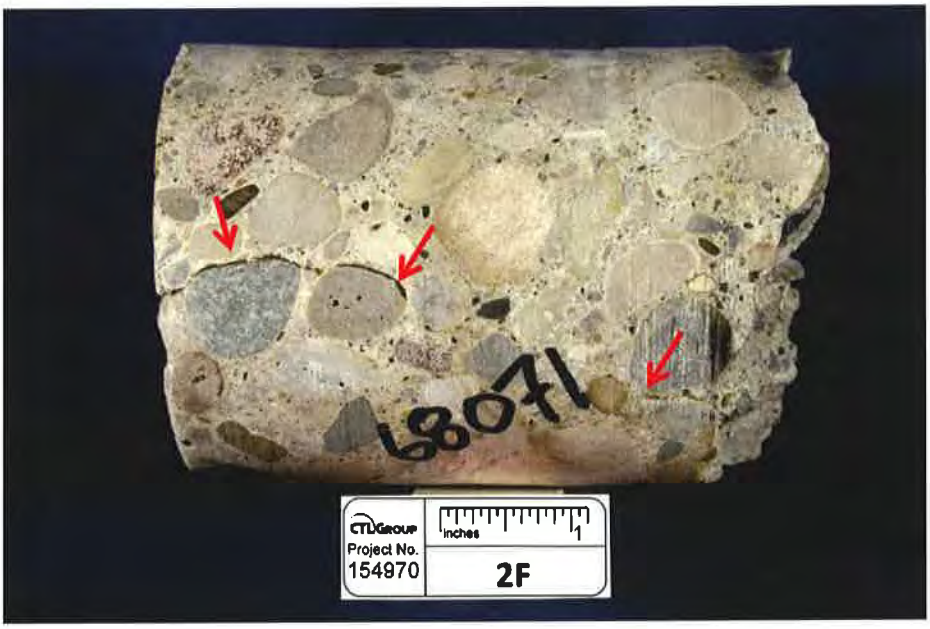
3c. Side view of Core 1E as received. Exterior surface at left. Red arrows point to irregularly-shaped large voids, which appear due to under-consolidation. The green arrow points to a square-shaped reinforcement bar in the concrete.

Fig. 3 Core 1E, as received for testing.

4a. Exterior surface.

4b. Interior surface.

(Continued)



4c. Side view of Core 2F as received. Exterior surface at left. Red arrows indicate a crack/microcrack extending around aggregate particles.

Fig. 4 Core 2F, as received for testing.

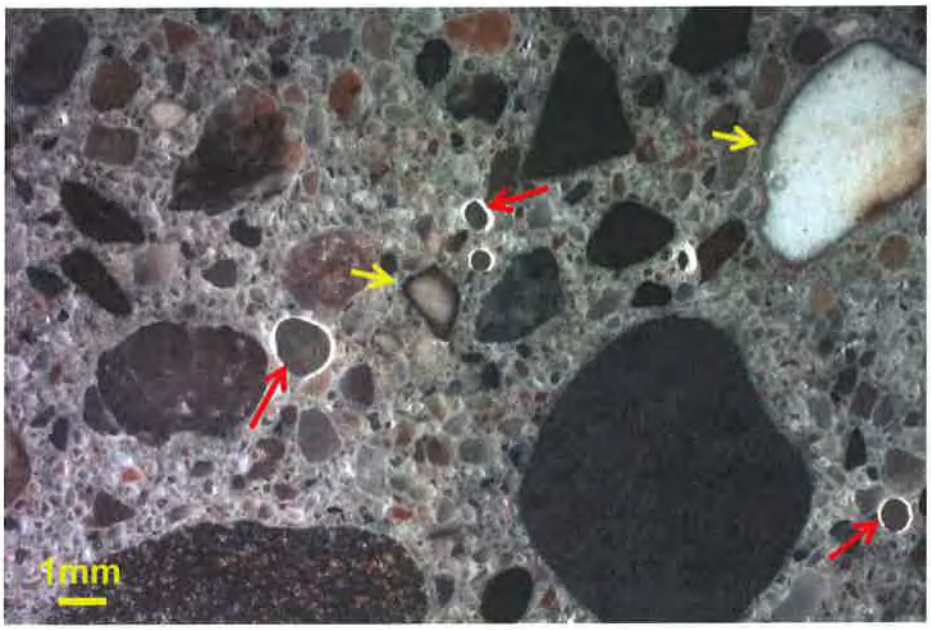


Fig. 5 Close-up view of Core 2B, showing scarcity of small, spherical voids in hardened paste. The concrete is not air-entrained. Red arrows indicate a few voids. Yellow arrows indicate aggregate particles with darkened rims. All four cores exhibit a similar air-void system.

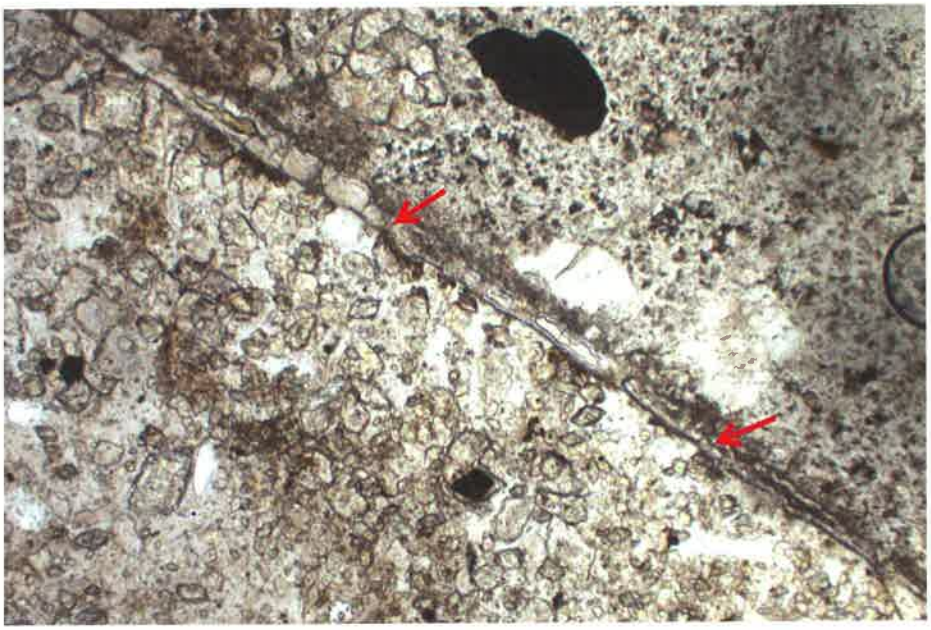


Fig. 6 Transmitted light photomicrograph of Core 1C, showing ASR gel (red arrows) along periphery of an aggregate particle. Field of view is approximately 1.4 mm (0.06 in.) across. Plane-polarized light.

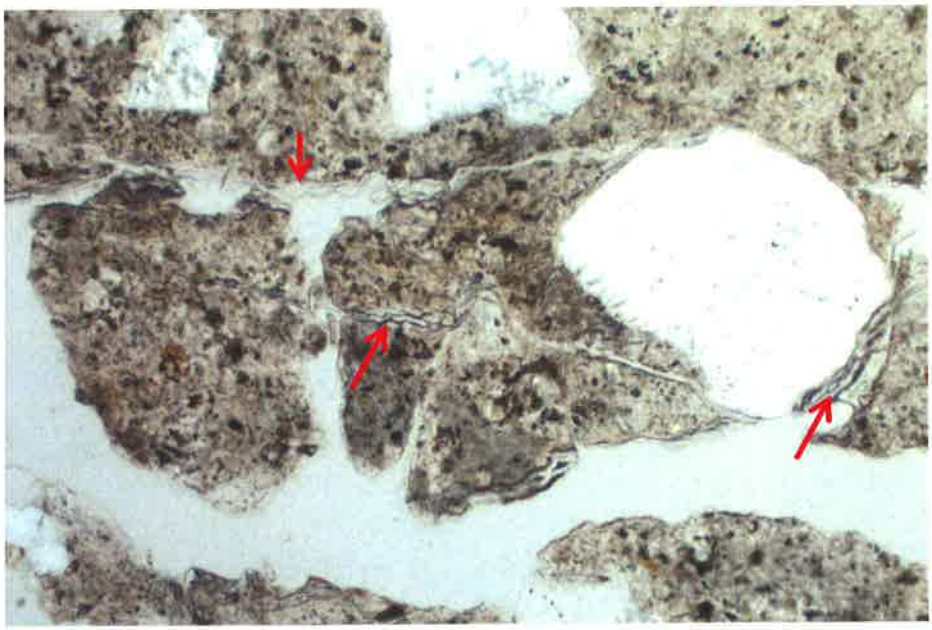


Fig. 7 Transmitted light photomicrograph of Core 2F, showing ASR gel (red arrows) in microcracks. Field of view is approximately 0.7 mm (0.03 in.) across. Plane-polarized light.

Fig. 8 **Lapped section of Core 2B. Exterior surface at left. Red arrows indicate a segment of steel reinforcing bar.**

Fig. 9 **Lapped section of Core 1C. Microcracks on the surface were traced with a black marker, for visibility in the image. The actual microcracks are much narrower than the tracings. Top surface at left. Red arrows indicate a segment of steel reinforcing bar.**

Fig. 10 Lapped section of Core 1E. Microcracks on the surface were traced with a black marker, for visibility in the image. The actual microcracks are much narrower than the tracings. Exterior surface at left.

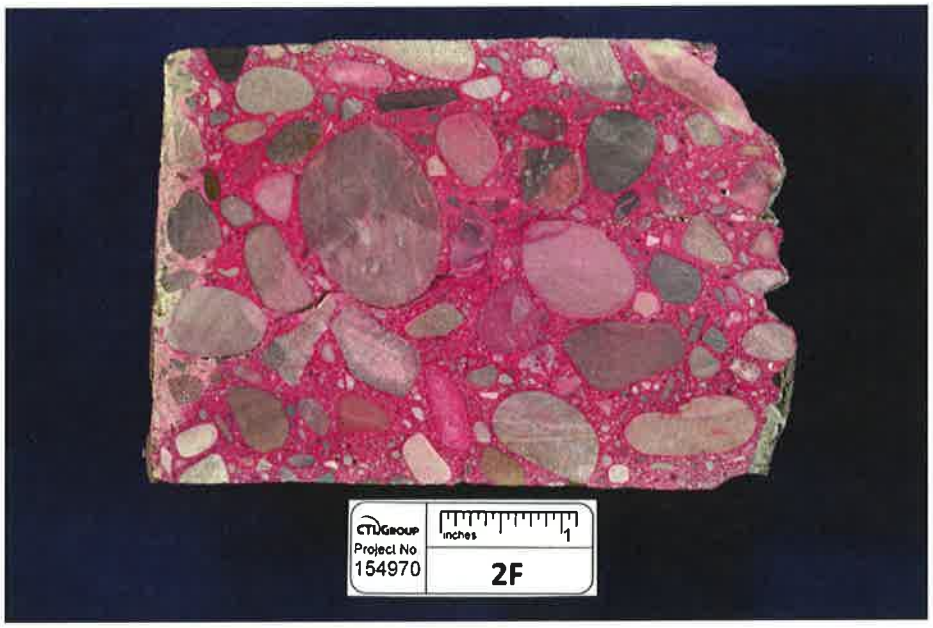
Fig. 11 Lapped section of Core 2F. Microcracks on the surface were traced with a black marker, for visibility in the image. The actual microcracks are much narrower than the tracings. Exterior surface at left.

12a. Core 2B. Depth of carbonation is 12 mm (0.5 in.) from exterior concrete surface. Exterior surface at left.

12b. Core 1C. Depth of carbonation is 1 mm from exterior concrete surface. Top surface at left.

(Continued)

12c. Core 1E. Depth of carbonation is negligible from exterior concrete surface. Exterior surface at left.



12d. Core 2F. Depth of carbonation is 5 mm from exterior concrete surface. Exterior surface at left.

Fig. 12 Freshly saw-cut surfaces of the cores, which were subjected to an application of a pH indicator solution (phenolphthalein), to evaluate paste carbonation. The solution imparts a deep magenta stain to high pH, non-carbonated paste. Carbonated paste does not change color.

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Pit Wall of Bridge

DATE RECEIVED: September 11, 2013

LOCATION: Bay City, Michigan

EXAMINED BY: Q. Li

SAMPLE

Client Identification: 2B.

CTLGroup Identification: 3506801.

Dimensions: Core diameter = 94 mm (3.7 in.). Core length = 214 mm (8.4 in.); partial wall thickness.

Exterior End: Generally flat concrete surface, which is covered a mortar topping, generally 2-mm (0.08-in.) thick but locally thicker; paste in mortar is dark reddish brown and hard.

Interior End: Rough and uneven fractured surface. Paste is light to medium gray and hard. The fracture extends through the most of aggregate particles.

Cracks, Joints, Large Voids: A few irregularly-shaped large voids are noted, measuring up to 25 mm (1.0 in.) long and 15 mm (0.6 in.) wide. No cracks or joints are observed.

Reinforcement: A surface-parallel, square-shaped steel reinforcing bar is noted, with 38 mm (1.5 in.) concrete cover. Diagonal length of cross-section of the steel bar is 12 mm (0.5 in.). A small amount of corrosion product is observed on the surface of the steel bar.

AGGREGATES

Coarse: Natural gravel composed mainly of limestone, cherty limestone, cherty dolostone, sandstone, quartzite, granite, and other igneous and metamorphic rocks.

Fine: Natural sand composed mainly of quartz, limestone, quartzite, chert, feldspar, and other minerals and rocks.

Gradation & Top Size: Visually appears somewhat evenly graded to an observed top size of 39 mm (1.5 in.).

Shape, Texture, Distribution: Coarse- rounded to sub-rounded, and equant to slightly elongated with somewhat smooth surfaces; distribution is uniform. Fine- rounded to sub-angular, and mostly equant with smooth to somewhat rough surfaces; distribution is uniform.

PASTE

Color: Medium gray overall; medium beige-gray in the outer 5 to 10 mm (0.2 to 0.4 in.).

Hardness: Hard.

Luster: Subvitreous.

Paste-Aggregate Bond: Moderately tight.

Air Content: Estimated 1 to 2%. Concrete is not air-entrained.

Depth of Carbonation: Approximately 12 mm (0.5 in.) along exterior surface.

Calcium Hydroxide*: Estimated 10 to 15%, generally comprised of small sized crystals distributed throughout cement paste and along periphery of aggregate particles.

Residual Portland Cement Clinker Particles Error! Bookmark not defined.**:** Estimated 1% unhydrated and partially hydrated portland cement particles.

Supplementary Cementitious Materials Error! Bookmark not defined.**:** None observed.

Secondary Deposits: None observed.

MICROCRACKING: None observed.

ESTIMATED WATER-CEMENT RATIO: Not provided due to the reported age of the concrete and the advanced hydration of the concrete.

MISCELLANEOUS:

1. Paste exhibits moderately high water absorbency.
2. Some aggregate particles exhibit darkened rims; however, no ASR gel or related cracks/microcracks are noted around those aggregate particles.

---

*percent by volume of paste

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Bridge Deck
LOCATION: Bay City, Michigan

DATE RECEIVED: September 11, 2013
EXAMINED BY: Q. Li

SAMPLE

Client Identification: 1C.

CTLGroup Identification: 3506802.

Dimensions: Core diameter = 94 mm (3.7 in.). Core length = 206 mm (8.1 in.); partial bridge deck thickness.

Top End: Generally flat, somewhat rough, finished surface. Paste is dark brownish gray and hard.

Bottom End: Rough and uneven fractured surface. Paste is light to medium gray and hard. The fracture extends through and around aggregate particles. A No. 8 steel reinforcing bar is embedded in the bottom surface.

Cracks, Joints, Large Voids: A few irregularly-shaped entrapped voids are noted, measuring up to 12 mm (0.5 in.) long and 10 mm (0.4 in.) wide. No cracks or joints are observed.

Reinforcement: A surface-parallel, No. 8 steel reinforcing bar is noted, with a 175 mm (6.9 in.) concrete cover. No corrosion products are observed on the steel bar surface.

AGGREGATES

Coarse: Natural gravel composed mainly of limestone, cherty limestone, cherty dolostone, sandstone, quartzite, granite, and other igneous and metamorphic rocks.

Fine: Natural sand composed mainly of quartz, limestone, quartzite, chert, feldspar, and other minerals and rocks.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 29 mm (1.1 in.).

Shape, Texture, Distribution: Coarse- rounded to sub-rounded, and equant to slightly elongated with somewhat smooth surfaces; distribution is uniform. Fine- rounded to sub-angular, and mostly equant with smooth to somewhat rough surfaces; distribution is uniform.

PASTE

Color: Medium gray overall; locally light gray. Medium beige in the upper 1 mm (0.04 in.).

Hardness: Hard.

Luster: Subvitreous.

Paste-Aggregate Bond: Moderately tight.

Air Content: Estimated 1%. Concrete is not air-entrained.

Depth of Carbonation: Approximately 1 mm (0.04 in.) along top surface.

Calcium Hydroxide*: Estimated 10 to 15%, generally comprised of small sized crystals distributed throughout cement paste and along periphery of aggregate particles.

Residual Portland Cement Clinker Particles Error! Bookmark not defined.**:** Estimated 1 to 2% unhydrated and partially hydrated portland cement particles.

Supplementary Cementitious Materials Error! Bookmark not defined.**:** None observed.

Secondary Deposits: Ettringite crystals line a few voids. A few ASR gel deposits were observed along periphery of aggregate particles.

MICROCRACKING: A very few short, discontinuous, and randomly-oriented microcracks are present in paste.

ESTIMATED WATER-CEMENT RATIO: Not provided due to the reported age of the concrete and the advanced hydration of the concrete.

MISCELLANEOUS:

1. Paste exhibits moderately high water absorbency.

2. Some aggregate particles exhibit darkened rims; however, no cracks or excessive microcracks are noted around those aggregate particles.

---

*percent by volume of paste

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Pit Wall of Bridge
LOCATION: Bay City, Michigan

DATE RECEIVED: September 11, 2013
EXAMINED BY: Q. Li

SAMPLE

Client Identification: 1E.

CTLGroup Identification: 3506803.

Dimensions: Core diameter = 94 mm (3.7 in.). Core length = 280 mm (11.0 in.); full bridge deck thickness.

Exterior End: Generally flat, somewhat rough, formed surface. Paste is dark brown and hard. A few irregularly-shaped voids are present on the surface.

Interior End: Flat and smooth saw-cut surface.

Cracks, Joints, Large Voids: Irregularly-shaped large voids are common in the concrete, measuring up to 40 mm (1.6 in.) long and 20 mm (0.8 in.) wide. No cracks or joints are observed.

Reinforcement: A surface-parallel, square-shaped steel reinforcing bar is noted, with 97 mm (3.8 in.) concrete cover. Diagonal length of cross-section of the steel bar is 12 mm (0.5 in.). No corrosion products are observed on the steel bar surface.

AGGREGATES

Coarse: Natural gravel composed mainly of limestone, cherty limestone, cherty dolostone, sandstone, quartzite, granite, and other igneous and metamorphic rocks.

Fine: Natural sand composed mainly of quartz, limestone, quartzite, chert, feldspar, and other minerals and rocks.

Gradation & Top Size: Visually appears slightly unevenly graded to an observed top size of 30 mm (1.2 in.). Volume of intermediate sized coarse aggregate appears low.

Shape, Texture, Distribution: Coarse- rounded to sub-rounded, and equant to slightly elongated with somewhat smooth surfaces; distribution is uniform. Fine- rounded to sub-angular, and mostly equant with smooth to somewhat rough surfaces; distribution is uniform.

PASTE

Color: Medium to dark gray.

Hardness: Hard.

Luster: Subvitreous.

Paste-Aggregate Bond: Moderately tight.

Air Content: Estimated 3 to 5%. Concrete is not air-entrained. Several large irregularly-shaped voids, due to under consolidation, are present in paste.

Depth of Carbonation: Negligible along exterior surface.

Calcium Hydroxide*: Estimated 10 to 15%, generally comprised of small sized crystals distributed throughout cement paste and along periphery of aggregate particles.

Residual Portland Cement Clinker Particles Error! Bookmark not defined.**:** Estimated 1% unhydrated and partially hydrated portland cement particles.

Supplementary Cementitious Materials Error! Bookmark not defined.**:** None observed.

Secondary Deposits: White ettringite crystals line a few voids.

MICROCRACKING: Several short microcracks are present through the depth of the core, oriented fairly perpendicular to the exterior core end.

ESTIMATED WATER-CEMENT RATIO: Not provided due to the reported age of the concrete and the advanced hydration of the concrete.

MISCELLANEOUS:

1. Paste exhibits moderately high water absorbency.
2. Some aggregate particles exhibit darkened rims; however, no ASR gel or related cracks/microcracks are noted around those aggregate particles.

---

*percent by volume of paste

PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE, ASTM C856

STRUCTURE: Pit Wall of Bridge

DATE RECEIVED: September 11, 2013

LOCATION: Bay City, Michigan

EXAMINED BY: Q. Li

SAMPLE

Client Identification: 2F.

CTLGroup Identification: 3506804.

Dimensions: Core diameter = 94 mm (3.7 in.). Core length = 138 mm (5.4 in.); partial wall thickness.

Exterior End: Generally flat, somewhat rough, finished surface. Paste is dark brownish gray and hard. Locally paste is worn and some aggregate particles are exposed. A crack extends across the surface.

Interior End: Rough and uneven fractured surface. Paste is light to medium gray and hard. The fracture extends around and through aggregate particles.

Cracks, Joints, Large Voids: The crack from exterior surface extends through full-depth of the core, around aggregate particles. Width of the crack decreases with depths. No large voids or joints are observed.

Reinforcement: None observed in the core segment.

AGGREGATES

Coarse: Natural gravel composed mainly of limestone, cherty limestone, cherty dolostone, sandstone, quartzite, granite, and other igneous and metamorphic rocks.

Fine: Natural sand composed mainly of quartz, limestone, quartzite, chert, feldspar, and other minerals and rocks.

Gradation & Top Size: Visually appears evenly graded to an observed top size of 28 mm (1.1 in.).

Shape, Texture, Distribution: Coarse- rounded to sub-rounded, and equant to slightly elongated with somewhat smooth surfaces; distribution is uniform. Fine- rounded to sub-angular, and mostly equant with smooth to somewhat rough surfaces; distribution is uniform.

PASTE

Color: Medium to light gray overall; locally medium beige in the outer portion of the concrete, up to 20 mm (0.8 in.) deep.

Hardness: Hard.

Luster: Subvitreous.

Paste-Aggregate Bond: Moderately weak.

Air Content: Estimated 1%. Concrete is not air-entrained based on the scarcity of small, spherical voids in hardened paste.

Depth of Carbonation: Slightly carbonated up to 5 mm (0.2 in.) along exterior surface.

Calcium Hydroxide*: Estimated 10 to 15%, generally comprised of small sized crystals distributed throughout cement paste and along periphery of aggregate particles.

Residual Portland Cement Clinker Particles Error! Bookmark not defined.**:** Estimated 1% unhydrated and partially hydrated portland cement particles.

Supplementary Cementitious Materials Error! Bookmark not defined.**:** None observed.

Secondary Deposits: White ettringite crystals line a few voids. A small amount of ASR gel was observed in the vertical crack/microcrack. White calcium carbonate deposits are noted around a few aggregate particles.

MICROCRACKING: A very few, short, fine, discontinuous, and randomly-oriented microcracks are present in paste.

ESTIMATED WATER-CEMENT RATIO: Not provided due to the reported age of the concrete and the advanced hydration of the concrete.

MISCELLANEOUS:

1. Paste exhibits moderately high water absorbency.
2. Some aggregate particles exhibit darkened rims; however, no ASR gel or related cracks/microcracks are noted around those aggregate particles.

---

*percent by volume of paste

Appendix H – Meeting Minutes

H-1 Scope Verification Teleconference with MDOT (02-19-2013)

H-2 Kickoff Meeting Minutes (07-17-2013)

H-3 Drift Test Minutes (07-18-2013)

02/19/2013 Scope Verification Teleconference Meeting Notes
Lafayette Avenue Bascule Bridge Study

- Question: When considering the bridge replacement alternatives, do new alignment options need to be studied or should everything be based on maintaining the existing highway baseline with the assumption that the existing bridge will be out of service during the full duration of construction?

  Response: Consider same alignment only. Develop cost estimates for 2-lane and 3-lane bridge replacement bridge. The roadway will be closed to traffic during construction with MDOT providing a detour route that it has previously used when working on the bridge. Consider both single leaf and double leaf bascule bridge alternatives. URS will contact the USCG regarding navigational channel width and requirements for replacement options.

- Question: During the walk-through inspection, could a short duration (1-2 hours) roadway closure be arranged for inspecting the bridge in various open positions?

  Response: MDOT can arrange for this with a one to two week notice. A closure will need to be coordinated with a project just to the west that MDOT will be starting this spring. A short duration traffic closure may have to be done at non-peak hours such as before the morning rush hour, during the mid-day or after the evening rush hour period.

- Question: Are we correct in assuming that no testing of river bottom sediment will be required as part of the project? (The type of any contamination may affect the estimated cost of bridge replacement alternatives)

  Response: MDOT will provide any costs for potential contamination turned up by Jose/Steve (MDOT) for use in the cost estimates.

- Question: For bridge replacement alternatives, will the existing 5' sidewalk widths be maintained? Are there any needs for anything wider to accommodate bicyclists? Are there any issues currently with bicycles and pedestrians sharing the sidewalks?

  Response: Assume 5 foot for now, Steve will check if a wider sidewalk is needed. No on-roadway bike lanes should be considered with the alternatives.

- Question: To minimize travel costs, we would like to combine the project initiation meeting with the site review inspection that would be performed later that day and on the following day. Would there be any issues for MDOT in doing so?

  Response: Yes, meet first at the region's office then go to the site. The project initiation meeting and the walk through inspection together will last over two consecutive days.

  A separate follow-up inspection visit will be conducted later when a Reachall underbridge access unit will be provided by MDOT and combined with the one to two hour roadway closure noted above for additional bridge opening and closing related inspection work. The navigation season when a bridge operator will be on site begins on March 16.

- Question: We suggested in our response to the RFP conducting a "brain storming" session with MDOT during the early part of the project to review and discuss identified issues and formulate a wide-ranging list of options and alternatives for potential solutions. Would MDOT find this desirable? Could this potentially be arranged as part of the initial site walk-through inspection?

  Response: Yes, include in URS schedule. This will be planned to take place at the end of the walkthrough inspection visit on the afternoon of the day after the project initiation meeting..

- Question: The RFP noted assessing the condition of the steel grillages that support the track plates. The grillage beams (track girders) are completely encased in the bascule pier concrete and likely not at all visible. Does MDOT have any thoughts on what they would like to see for this assessment, short of removal of the encasing concrete?

  Response: This work will not be included in the Consultant's scope as the grillage beams are encased in concrete and cannot be readily inspected.

- Question: Since it was recently performed in 2011, we do not plan to strain gage balance test the bridge. A simple means to verify the balance condition again would be to perform drift tests of the leaves in various positions of opening. This would entail releasing the brakes with power removed from the drive motors in various opening positions. Would MDOT be able to assist with this effort when we are on site by operating the bridge and manually releasing the brakes?

  Response: Yes, a drift test, MDOT will provide staff to do this.

- Question: The RFP noted MDOT may be able to provide an under bridge inspection unit (Reachall) to inspect portions of the structure. How much lead time will be required to schedule that equipment?

  Response: MDOT can provide an under bridge inspection unit with a reasonable amount of advance notice from the Consultant.

- Question: The RFP notes analysis of substructure movement (if any). We assume that no instrument survey for measuring movements will be required for this in the work scope.

  Response: MDOT is currently having it surveyed/monitored. Data will be provided to URS.

- Question: Is a traffic detour route study required?

  Response: There is a detour route for working on this project that MDOT has previously used. MDOT will provide a cost for furnishing and maintaining this detour route for including in the bridge alternative cost estimates.

- Question: Is there any need to perform any traffic counts as part of the study?

  Response: MDOT will provide traffic data. URS will not need to evaluate traffic demand versus laneage. A three lane structure would better accommodate future bridge maintenance with one lane being able to be closed for an under bridge access unit. Consider a minimal amount of construction work scope for road work – perhaps 40 feet beyond the back of bridge abutments necessary to transition to the existing roadway. URS would provide footprint of the bridge. MDOT would in-turn provide any associated right-of-way estimated costs.

- Question: Will we need to meet with local officials and/or other stake holders (other than MDOT) in order to gain input for the study. For example do we need to document their input concerning the ramifications of a major rehabilitation versus a replacement project?

  Response: No.

- Question: For the bridge replacement alternatives should be assume that the existing horizontal and vertical clearances are required for the navigational channel?

  Response: Coordinate with USCG. URS will first coordinate with MDOT before initiating any contact with the Coast Guard.

- Question: Will we be able to obtain current annual bridge operating and maintenance cost data from MDOT?

Response: Yes, MDOT will provide this.

- Question: Are there any historic significance studies required?

  Response: The bridge is historic, but URS will not have do anything related to this issue other than including a brief paragraph just touching on this point.

- Question: Are any socioeconomic studies required?

  This was not discussed during the meeting but based on related topics discussed; URS will assume none are required.

- Question: For the bridge replacement alternatives, should any considerations be given to incorporating remote operation for either this bridge or the other one within the City that is also under MDOT jurisdiction?

  Response: Due to heavy pedestrian use, no provisions for remote operation should be considered.

- Question: For the rehabilitation alternative, should the work include replacement of the traffic railing since it is not one currently classified as crash worthy?

  Response: Yes, the railing should be replaced if it is not one currently in their standards. The FHWA would likely be ok with some minor modifications to a crash tested system such as joints in railing that are required because they are unique and necessary for a movable bridge. A crash tested railing from another state could also be considered.

- Question: Can MDOT provide a boat for inspecting elements of the substructures near water level?

  Response: MDOT will provide boat during the follow-up site inspection, when the under bridge access unit is also furnished.

- Question: Should a section be provide in the report addressing short term repairs that are needed before a major bridge rehabilitation or replacement bridge is built?

  Response: NO MDOT will follow the recommendations for scheduling and making the near term repairs that are provided in the H&H inspection report. URS will only look at rehabilitation and replacement work scopes.

Follow-up action items by MDOT:

- MDOT will provide URS the roadway cross section (geometry) to consider for the replacement alternatives.
- MDOT (Region) will provide R.O.W. acquisition costs for alternatives if required.
- MDOT will check to see if bridge load rating information is current and let URS know if anything is needed for this.
- MDOT will look for the existence of substructure calculations from the 1990 superstructure replacement project, when the span weight was greatly increased.

URS and MDOT will work together on a revised project schedule since the anticipated start date noted in the RFP of January has already passed.

URS with its subconsultant Soil and Materials Engineers, Inc. will develop an assumed number of locations where petrographic examination and compressive strength testing will be performed as part of the work scope for assessing the condition of the substructures and estimating their remaining life.

URS

Meeting Minutes

Date: July 17, 2013
Time: 9:00 AM
Place: Bay City TSC

Subject: Kick-off Meeting / Site Visit / Brainstorming Meeting
M-13/M-84/Lafayette Ave. over E. Channel Saginaw River
CS 09032, JN 117082

Attendees:

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Kick-off Meeting:

1. URS should assume the capacity of the piles supporting the bascule piers is as shown on the existing plans if shown. (In follow-up to this item, Linda Reed noted by Email on 07/24/13 that it does not have pile driving records from the initial construction that the original plans are difficult to read, but limited soil boring information can be found on page 2 of "Lafayette plans1.pdf". A note on page 6 reads "piles assumed 45' long for estimating purposes".)
2. The desired life for a bridge rehabilitation is "as long as possible" but it could be controlled by an existing weak link such as foundation conditions or a scour critical situation.
3. The bridge was determined by MDOT to be scour critical. A 3D image was recently taken below the water. Linda will provide this to URS along with the diver's report. (In follow-up to this item, Linda Reed provided by Email on 07/24/13 the 2010 Underwater Inspection Report and Scour Action Plan. She will also post the entire diving inspection report on the ftp site after locating it. In that Email she also noted the Jose Garcia mentioned that the use of micro piles should be considered for scour mitigation or to increase foundation capacity.)

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4. Scour countermeasures should be included in the work scope of the rehabilitation alternative. For a new bridge, the footings would be set deep enough to be below the contraction scour. MDOT is currently looking into the scour situation at the bridge.
5. Accessibility for drilling crack relief holes has been problematic at the floorbeam web cracks at coped ends.
6. MDOT recognizes the existing steel grillage embedded in the bascule piers beneath the tracks is an issue. Rehabilitation needs to consider replacement or rebuilding the grillage and would require removal of the encasing pier concrete.
7. During a previous rehabilitation project, the top flange of one of the track girders/grillages was removed or replaced due to its poor condition.
8. Finger joints and longitudinal break joints in the sidewalk of the bascule span cause bike tire crash issues which is a safety issue.
9. The design speed is 35 mph.
10. MDOT has no predetermined course of action, therefore the report should objectively evaluate the options of bridge rehabilitation and bridge replacement.
11. The report should briefly discuss a single leaf replacement option, but it will likely be discarded for reasons that include lack of redundancy, increased structure depth over the navigation channel, span length and other factors that make it less effective than a double-leaf bascule structure.
12. URS will need to confirm waterway opening requirements with the coast guard. MDOT will provide the contact information. MDOT should be copied on all communications. (In follow-up to this item, Linda Reed responded by Email on 07/24/13 that the contact person at the Coast Guard is Lee Soule with Email address Lee.D.Soule@uscg.mil)
13. All bascule bridges in Michigan are considered to be eligible for the National Register of Historic Places. The report should simply mention this and need not take the issue any farther.
14. MDOT recently installed automatic survey monitoring instrumentation on the bridge to record movements in the tread and track area. There is a website where this information can be found. Chris has access to about 6 months worth of data. (In follow-up to this Item, Linda Reed provided by Email on 07/24/13 information on the web page where all of the survey monitoring data is available for viewing and download - https://geomos.leica-geosystems.com/GeoMoSWeb/Login.aspx Login = MDOT3 Password = monitor3)
15. The report needs to include an executive summary.
16. Key photos should be placed in the body of the report and other photos included in an appendix.
17. Cost estimates should include calculated quantities of materials for significant items where appropriate.
18. Follow the MDOT repair matrix for the approach spans. MDOT will provide the matrix. (In follow-up to this item, Linda Reed provided by Email on 07/24/2013 a copy of MDOT's Bridge Deck Preservation Matrix. This is the tool its uses to determine appropriate deck rehab options based on the condition of the deck surface and underside, and also lists the anticipated fix life of each repair option. The version provided is for use for decks with epoxy coated rebar, which is believed to be what the approach spans have.)
19. Linda Reed noted the Life Cycle Cost Analysis should be based on a discount rate of 4%. (In follow-up to this item, she also provided by Email on 07/24/2013 documents for a sample of bridge rehabilitation life cycle cost analysis.)
20. Because an open steel grid deck results in more painting and repairs, the replacement alternative should include a solid deck for the bascule span.
21. Due to heavy operation in the summer, maintenance painting on the bascule portion can only be performed in the winter. Because of this, paint quality is not as good and the cost is higher. Approach spans can be painted anytime.

22. Bridge tender opening logs with two years of data will be provided to URS. Bridge opening for commercial navigation is on demand while openings for recreational navigation is based on a schedule of times.
23. Remote operation should not be included in the report.
24. URS will submit a draft outline of the report for MDOT to review.
25. The drift test will be performed to evaluate the balance condition of the bascule leaves.
26. The current load rating is available on the MDOT FTP site.
27. For the August 13 meeting, MDOT will provide a boat and underbridge access. Only one lane will be required to be maintained during the inspection. The preference is to not perform bridge openings between 11am and 1pm.
28. URS is to contact Steve and Chris during Linda's vacation from August 2 to August 17.
29. The schedule is important to be maintained.
30. Each submittal should consist of 4 hard copies plus an electronic copy.
31. Pit floor capacity for jacking should be evaluated and included in the report.
32. The bridge replacement alternative needs to take into account current design requirements for vessel collision protection systems. Those requirements may require a more robust dolphin and fender system that could affect how long a new bascule span would need to be.
33. The side plates connecting the flange and tread plates were added in 2001. Additional plates were added in 2010. Bolts connecting the tread and flange plates have been sheared – this was confirmed by ultrasound. The bolts connecting the track to the sole plate sheared in 1991. The track plate was first observed to "lift" during operation in 2009.

Site Visit:

1. During the site visit, various portions of the bridge were observed and numerous discussions with maintenance staff were had about conditions and past history.
2. The bascule leaves were raised and lowered several times.
3. Key issues were observed during operations including:
    a. Track plate movement is exhibited when the bridge is opened and closed - most notably in the NW quadrant . Bolts connecting the two plies of track plates have failed. Light gauge angles have been welded to the sides of the two track plates to hold them together.
    b. Numerous bolts between the two plies of tread plates and the bascule girder flange angles have also failed. MDOT has welded side plates along the full length of roll to hold these elements together. MDOT has a monitoring system set up in the NW quadrant.
    c. Wear of the pintles in the track plates is significant due to longitudinal movement of plates allowing misalignment with mating pockets in the tread plates. Loud grinding noises coming from the mating of the SW track pintles and tread plate receiving holes were heard during the bridge operations made during the site visit.
    d. The backup drive does not work.
    e. The main drive motors are hot to the touch.
    f. The generator room is small with limited air flow. Retrofits of the room would not be warranted.
    g. The far leaf treads exhibit active interference with the track pintles. Plastic flow is evident on the tread and track plates. The tread plates have indentations reflecting the countersunk holes in the track.
    h. The near leaf treads exhibit past wear of the pintles, but the interference does not appear to be active. It appears that fewer bolts have been sheared off on the near leaf tread plates compared to the far leaf.

i. Concrete has been chipped off the sides of the bascule pier mass pours in the NW and SE quadrants in an attempt to correct a problem of interference and rubbing by the deck longitudinal breaks when the bridge is opened. It was observed during several openings that the clearance is still very tight at these locations.

Brainstorming Meeting:

1. For the rehabilitation alternative, URS said it would recommend a complete replacement of the track plates, tread plates, and bascule girder bottom flange angles because there realistically is no good piecemeal solution to permanently correct the issues with those elements.
2. No welding of machined parts will be allowed due to warpage.
3. Plastic flow and resulting track plate deformation that has occurred and caused bolt failures was explained with a strut and tie model.
4. A feasible concept for replacing the tread and track plates was presented by URS and discussed. Sketches of the concept were drawn and described.
5. There is a 3 month window closure to navigation for the waterway during the winter when work could be performed with the bridge left in the closed position. If work were to be performed at other times of the year, it would have to be performed with the bascule leaves shored in the open position. Work quality would likely be better if performed in the warmer time of year and shoring the leaves in the open position to enable it appears to be feasible.
6. The finite element analysis should focus on the proposed rehabilitation solution instead of determining why the existing situation with failing plates and connectors has occurred.
7. High strength forgings or castings would be provided to replace the existing two-ply tread and track plate systems. Forgings rather than castings would likely be used due to their cost effectiveness and better predictability of internal quality. On modern rolling lift bascule bridges these elements are typically specified with a yield strength in the range of 75 to 90 ksi.
8. URS will discuss with its subconsultant SME the possibility of them attending the August 13 inspection and then having them come back a different day to perform the actual corings of concrete in the bascule piers. For cores taken in the counterweight pit it may require a short term outage of bridge openings. May need to discuss with USCG the possibility of a 8 hour night time outage. This will be discussed with SME.
9. Replacing the concrete filled steel grid sidewalk with a slip resistant steel plate may be an option to reduce dead load on a rehabilitated bridge.
10. Because of the very good condition of the existing bridge railing, it should be kept if possible. However, that railing is not currently classified by MDOT as a crash-worthy system and therefore if it needed to be temporarily removed as part of a rehabilitation it may have to be replaced. URS will investigate whether it may match a crash-worthy railing from some another state DOT.
11. Any reduction in dead load would be a benefit to the scour critical foundations because it would reduce loads on the supporting piles that may be partially exposed with reduced lateral support.
12. Based solely on its age and the time frame for a rehabilitation, URS tentatively suggested that a rehabilitation of the bascule span should include replacement of its deck, roadway center breaks and rear breaks and sidewalk front, back and longitudinal breaks.
13. The motor drives should be replaced because replacement parts are no longer available for the existing 1987 drives. URS suggested replacing most of the controls in conjunction with replacing those drives.
14. The backup drive system currently does not work and a reliable working one should be provided.
15. The generator should be relocated or replaced and located on shore.

16. The rear lock systems should be reconditioned. Alternately, portions of them may need to be replaced.
17. The existing Westinghouse machinery brakes are obsolete and came from the old bridge. They should be replaced.
18. New traffic gates are needed as the existing ones have been problematic and not worth re-building based on their age.
19. Surveillance cameras should be considered for both rehabilitation and replacement options to provide the operator with more and better visual information when operating the bridge.
20. Bridge House air conditioning may need to be replaced
21. The sump pit pumps do not need to be replaced as they are fairly new.
22. Consideration will be given to developing a concept for repairing the floorbeams that support the open steel grid system of the bascule bridge to address the cracks that developed in the coped upper portion of their webs where they connect to the bascule girders. Floor beam replacement can likely be avoided as part of the rehabilitation alternative.
23. Based on when funding may potentially be available, 2018 would be the earliest that a major rehabilitation could be performed and 2020 the earliest that a complete replacement could be constructed.
24. MDOT stated that the bridge deck section for the bridge replacement alternative should be based on a width of three 12-foot lanes plus 2-foot shy distances to the curb for a curb-to-curb width of 40 feet. 5-foot sidewalks should also be assumed on both sides of the roadway.
25. The phone number for the bridge tower is 989-895-8851.

URS

Meeting Minutes

Date: July 18, 2013
Time: 9:00 AM
Place: Bay City TSC

Subject: Drift Test
M-13/M-84/Lafayette Ave. over E. Channel Saginaw River
CS 09032, JN 117082

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Drift Test:

1. A drift test was performed on each bascule leaf. The purpose of this test was to confirm the current state of balance for each bascule leaf. To perform this test, each bascule leaf was brought to several positions of opening from nearly closed to fully open at approximately 15° intervals, the power then removed and the brakes released. The direction in which the leaf tended to drift provided a direct indication of how well balanced each leaf is about the center of roll as the leaves rotate about their axis.
2. Following is a summary of what was observed from the drift test of the east bascule leaf:
   At 15° the leaf slowly drifted down to 12° then stopped. To determine if the leaf imbalance (i.e. tip heavy condition) increased as the angle of the leaf decreased the leaf was lowered to 6.2° in which the leaf slowly drifted to 5.7° and stopped.
   At 30° the leaf slowly drifted down to 26.4°, stopped, then drifted back up to 27.4° before stopping again.
   At 45° the leaf drifted up and started to pick up speed until the leaf was stopped via the motor brake.
   At 61° the leaf did not drift.
   In summary the east leaf has very little imbalance. It is common for a leaf to have 1-2 kips at the tip of imbalance at the fully lowered position. This helps with seating the leaf and preventing the leaf from bouncing back up prior to engaging the tail lock system. The erratic movement of the leaf also indicated the track is not flat and/or the tread is not round, causing the leaf to move due to hills and valleys rather than imbalance.

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3. Following is a summary of what was observed from the drift test of the west bascule leaf:
   At 15° the leaf did not drift. The leaf was lowered to 6° in which the leaf slowly drifted to 5° and stopped.
   At 30° the leaf slowly drifted down to 25.6°, stopped, then drifted back up to 26.9° before stopping again.
   At 45° the leaf did not drift.
   At 60° the leaf drifted up to 60.1° then stopped.
   In summary the west leaf also has very little imbalance. The west leaf also exhibited erratic movement indicating the track is not flat and/or the tread is not round, causing the leaf to move due to hills and valleys rather than imbalance.
4. It was noted that the approach span sidewalk concrete has significant cracking issues throughout and some spalling along the curb lines. To replace those sidewalks as part of a bridge rehabilitation alternative, the bridge railing system would need to be temporarily removed.
5. The front, back and longitudinal sidewalk breaks of the bascule span were more closely inspected. They are in poor condition and should be replaced as part of a bridge rehabilitation alternative.
6. The roadway center breaks and rear breaks of the bascule span are tight. Some trimming of the center break teeth has been performed in the past to address issues of binding.
7. There is excessive “play” in the jaw and diaphragms of the center locks. At the north centerlock the gap is at the top. At the south centerlock the gap is at the bottom. The center locks should be re-shimmed as part of a bridge rehabilitation alternative to address this issue that results in a pounding action when heavy vehicles cross the bridge.
8. The north sidewalk center break teeth are too high on the east leaf as a result of the improper adjustment at the centerlock.
9. The concrete overfill on the filled grid sidewalk decks exhibits spalling and the underlying grid is exposed.
10. It was confirmed that there is no overlay on the decks of the approach spans.
11. It was not possible to view the underside of the decks of the approach spans. During the follow-up inspection using an under-bridge access unit on 08/13, the undersides of the approach span decks will be inspected and any cracks and efflorescence documented.