Project Report

Indian Lake Property Owners Association

Bridge Inspection and Report

Cochran Project Number: SC17-683

April, 2017

Presented to:

Indian Lake Property Owners Association

Ms. Mary Beth Huffman

STATE OF MISSOURI
TARY TODD
NUMBER
E-24182
REGISTERED PROFESSIONAL ENGINEER

4/7/17
Date

Tary Todd, P.E. #E-24182
State of Missouri
Registered Professional Engineer for Cochran

COCHRAN

Architecture • Civil Engineering • Land Surveying • Site Development • Geotechnical Engineering • Inspection & Materials Testing

530A East Independence Drive
Union, Missouri 63084
Telephone: 636-584-0540
Fax: 636-584-0512

737 Rudder Road
Fenton, Missouri 63026
Telephone: 314-842-4033
Fax: 314-842-5957
www.cochran.com

8 East Main Street
Wentzville, Missouri 63385
Telephone: 636-332-4574
Fax: 636-332-0760

Report Scope:

Indian Lake is a private lake community located near Cuba, Missouri. The Indian Lake Property Owners Association (ILPOA) retained the services of Cochran to inspect and report on the condition of the existing bridge located on Cove No. 9 at the headwaters of the lake where Brush Creek enters Indian Lake. The bridge is located on Lakeshore Drive which connects the west side of Indian Lake to the community entrance off Highway DD on the east side of the lake. The bridge on Lakeshore Drive is the only way for residents on the west side of the lake to get in and out. Emergency access across the dam is possible as long as the spillway is not flowing. This bridge is an important piece of infrastructure to the lake community.

The bridge was inspected by Robert Klein, the Infrastructure Assessment Chairman, in early March of 2017 while the lake level was down. The ILPOA lowers the lake level every 4 years to facilitate inspections and repairs on docks, seawalls and other infrastructure. During this inspection, several issues were noted on the bridge which was estimated to be built in the 1960's. This inspection, along with problems with the approach roadways to the bridge, prompted the ILPOA to close the bridge to traffic and contact Cochran to perform a detailed inspection of the bridge.

The scope of the work to be performed by Cochran includes a structural evaluation of the existing bridge, determine if the bridge could be re-opened to traffic, make recommendations on necessary repairs or replacement, perform load rating calculations to determine the safe load carrying capacity of the structure and provide a cost estimate for the replacement of the bridge.

Existing Bridge:

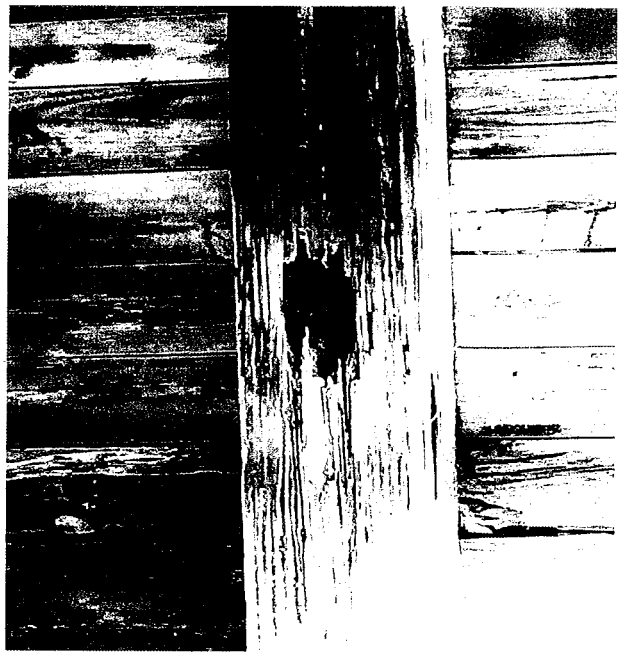
The existing bridge has a span length of approximately 24 feet. It is a single span bridge consisting of a 9 ½" thick concrete deck supported by steel stringers. The steel stringers appear to be W12 x 26 beams. The steel I-beams are 12" tall with 6 ½" wide flanges. The beams are spaced at approximately 2 feet on center. The concrete deck was constructed using stay in place metal forms. Reports indicate that the bridge was originally built with a timber deck, with the current concrete deck installed sometime in the 1980's. The bridge deck is 19'-9" wide out to out with 11 ½" by 11 ½" concrete curbs on each side.

The bridge superstructure is supported by a timber substructure. The timber piles are approximately 11" by 11" square and there are six piles at each end bent with an approximate spacing of 4 feet. The bottom of the timber piles are encased and appear to be supported by a concrete footing which is founded on rock in most areas. The timber piles have a similarly sized timber header that supports the steel stringers.

Inspection Findings:

Overall the bridge appears to be in good condition considering its age. However there were several deficiencies noted during the inspection. Localized subsidence of the approach roadway triggered concerns about scour and the integrity of the structure. Robert Klein conducted an investigation into the scour issues and noted several locations where scour was evident underneath the bridge abutments and wing walls. This scour problem can lead to failure of the structure and roadway. With the lake level down, the scour areas were probed to determine the extent of the problem. The main scour areas were found at the west abutment and the southeast wing wall. Probing with a steel rod underneath the structure in these areas reached 48" in depth in most locations. The scour is occurring at the southeast wing wall where the stream hits the wall because the bridge opening appears to be too narrow for the size of the stream. There are also large slabs of concrete that are directing the current at the bottom of the wing wall and causing disturbances in the flow. The west abutment scour is a result of the waterway opening being too small and the absence of rock in the northern half of the abutment. It appears that the northern half of the west abutment is not founded directly on rock and the scour from the increased water velocities is undermining this weaker location.

The second issue is the loss of section and deterioration of one of the timber pilings in the east abutment. The pile in question is the second pile from the south on the east abutment. The deterioration occurs just above the normal lake level. The loss of section is concerning and reduces the piles capacity to carry load. The timber pile appears sound above and below the deteriorated area. See the photo below.



The third issue is the cracking in the concrete deck that is allowing water to infiltrate and saturate the concrete deck. This water infiltration has caused the metal stay in place forms to rust and the metal has completely rusted away in locations near the west abutment. Since the metal forming is not a structural component of the bridge, the deterioration of the metal pan is not a big concern. One of the main problems with using metal stay in place forms is that any water seeping into the concrete deck is trapped near the bottom of the concrete deck by the metal form. This leads to saturation of the concrete with causes it to deteriorate as well. With the metal forming completely gone in places, the water has started attacking the steel stringers causing them to rust as well. Application of roadway salt during the winter months contributes to accelerating the rusting of the steel members. The rusting of the steel beams is progressing to the point where section loss is occurring. Evidence of pack rust and delamination of the steel stringers is evident. See the photos below.

Another issue concerning the bridge is the lack of approved guardrail on the structure. Currently the bridge has approximately 12" high concrete curbs on both sides with a single rail of painted steel pipe approximately 3 feet above the bridge deck. While the condition of the pipe rail is good, it does not meet any of the typical standards that apply to safety barriers for bridges. This situation can create some liability issues for the ILPOA. See the photo on the next page.

Repair Recommendations:

Scour Problem - Scouring and undermining of the southeast wing walls and west abutment has led to problems with subsidence in the east approach roadway and concern for the support of the west abutment. The scour problems are directly related to the short length of the bridge and the narrow waterway leading into the lake. The small waterway opening increases the velocity of the flow through the structure which in turn increases the scouring action. While the only way to solve this problem is to replace the bridge with a longer structure that is properly sized to accommodate the flow into the lake, steps can be taken to protect the existing bridge from scour.

There are several methods to repair and protect the bridge from scour. High pressure grouting behind the wing walls and abutments exhibiting scour problems is one way to fill the voids in the earth fill behind the walls. If the grouting continues to the point where the grout is coming out from under the wall, it will form a hard barrier to prevent any future scour.

Another repair option that would probably be cheaper to implement is to pack the scour areas underneath the walls with a ½" clean aggregate and rod it back into the voided areas as much as possible. If the lake level can be lowered enough to expose the areas, then use a low slump concrete. Then cover the openings underneath the walls where the scour is occurring with a geotextile fabric and place rock blanket against the bottom of the walls. The rock blanket needs to consist of large rock (> 1 cu. ft.) in size with just enough smaller rock to fill in the voids. More than half of the rock blanket

should be rocks roughly the size of a 5 gallon bucket. The geotextile fabric will prevent the further loss of sediment from behind the wall.

Timber Pile Deterioration - The timber piling that is exhibiting deterioration and section loss can also be repaired in a couple of different ways. A second, new timber piling can be placed next to the deteriorated piling and the two piles bolted together. The key is to shim the new pile up to make sure it is in good contact with the timber header and then the bottom of the piling grouted in to make sure the bottom of the pile is fully supported, then the piles should be bolted together with ¾" diameter galvanized steel bolts with nuts and washers. Bolt the pile together every 12" on center.

Another option would be to cut out the deteriorated section of the piling making sure the cut section is in sound material and form up the missing section using a sonotube as a form. The form should extend two feet above and below the missing section to ensure a good connection. The sonotube may need to be cut lengthwise to fit around the ends of the cut off pile and to conform to the back wall. The sonotube needs to be of sufficient diameter to allow for a minimum of 6" of clearance around the pile. Then the area inside the sonotube can then be grouted full.

Water Infiltration and Beams Rusting – The localized areas near the west abutment where the deck is cracked up and allowing water to saturate the deck and has rusted out the metal forms needs to be repaired to stop the water penetration. While there is not an easy method to stop the rusting of the steel beams, preventing further water penetration into the deck will significantly slow the process down and prolong the life of the structure. It is recommended to remove the loose surface material on the deck and seal the cracked areas with a rapid setting, epoxy based concrete overlay system. A typical product in this arena is MasterSeal 350 Trafficguard which can be purchased through Carter-Waters, a contractor supply distributor. There is a Carter-Waters located in Washington, Missouri. Any epoxy based concrete overlay system would work in this situation to waterproof the deck and prevent moisture from reaching the steel members below. A commercial grade polyurethane or acrylic concrete sealer may be used for this purpose but it would need to be re-applied every few years to maintain its effectiveness. While it is important to treat the cracks and broken up areas of the deck, it may be prudent to treat the entire deck area to prolong the life of the deck. Follow all the manufacturer's recommendations that come with the product selected for best results.

Another option is to apply a heavy coat of CRS-2 asphalt emulsion and cover it with rock chips. This process, known as chip and seal, provides a waterproofing element to the bridge deck and would probably be the cheapest alternative, especially if it can be incorporated as part of a larger chip and seal project on your roadways.

Once steel has started to rust it is very difficult to stop the process, but one method to solve this problem is to sandblast the steel beams down to bare metal and then paint them to help prevent rust from starting. Without being able to remove the beams to sandblast and paint them in a shop environment, it would be very difficult to conduct this procedure on site and potentially environmentally hazardous to the aquatic life in the lake.

Load Rating Analysis:

A load rating analysis was conducted to determine the safe load carrying capacity of the bridge. A copy of the analysis is attached at the end of this report. In summary, the bridge should be posted for a 22 ton load rating. This is rating is based on a single unit (H20) truck. This is a two axle truck. Multi-unit trucks (3S2) should be limited to 40 tons. Bridges are typically posted once they rate below 23 tons. It is important to post the load limit on the bridge to ensure that insurance will cover any damage caused by a vehicle that is over the weight limit of the structure.

Conclusion:

As stated at the beginning of this report, the bridge is in good condition. At this point in time we are starting to see the beginning of the decline of the structure. This decline will accelerate unless proper maintenance is conducted. It is recommended that the repairs outlined in this report be implemented as soon as practical. The timber pile deterioration can be addressed the next time the lake level is lowered. Although the repairs recommended will help prolong the life of the bridge, it is highly recommended that the ILPOA start setting aside money in the budget to cover the eventual replacement of the bridge since it will be a significant cost. A construction cost estimate for the replacement of the bridge is attached at the end of this report. It is also highly recommended that a consulting engineer experienced in bridge design be retained to design the replacement structure to ensure that the bridge fits the site and is designed to be as maintenance free as possible while providing a long life cycle.

Bridge Rating

Project: SC17-683
Date: 4/4/2017

Member : W12 x 26 (Steel Stringer Span)

	Input:		
Span Length	24.00	Feet	
Stringer Spacing (S)	2.00	Feet	
Concrete Slab Thickness	9.50	Inches	
Dead Load	0.238	Kips/LF	
Estimate of Beam Weight	0.026	Kips/LF	
Loading per foot of beam	0.264	Kips/LF	
Dead Load Moment (DLM)	18.972	Ft-Kips	
Simple Span Live Load Moments, based on one wheel line			
HS20	125.3	Ft-Kips	
H20	105.1	Ft-Kips	
3S2	105.1	Ft-Kips	
MO5	145.7	Ft-Kips	
LL Distribution Factors			
One Lane	0.286		=S/7.0
Two Lane	0.364		=S/5.5
Live Load Moments			
HS20 (2 Lane)	45.564	Ft-Kips	
HS20 (1 Lane)	35.800	Ft-Kips	
H20 (1 Lane)	30.029	Ft-Kips	
3S2 (1 Lane)	30.029	Ft-Kips	
Moment Capacity of Stringer			
Section Modulus of Stringer	33.40	In.^3	
Section Loss Percentage	10.00	Percent	
Yield Strength of Steel	30.00	Ksi	
Moment Capacity of Stringer (MC)	75.15	Ft-Kips	
Bridge Ratings (Load Factor)			
Operating Rating HS20 (1 Lane) =	**39.1**	**Tons**	
Inventory Rating HS20 (2 Lane) =	**18.4**	**Tons**	
Posting Rating H20 =	**22.2**	**Tons**	Single Unit
Posting Rating 3S2 =	**40.8**	**Tons**	Others

Indian Lake POA
Cove No. 9 Bridge Replacement
Preliminary Construction Cost Estimate
Project No. SC17-683

Single Span (50') with vertical end bents

Bid No.	Description	Unit	Quantity	Unit Cost	Extended Cost
2022010	Removal of Improvements	LS	1	$5,000.00	$5,000.00
2035000	Unclassified Excavation	CY	333	$15.00	$4,995.00
2035500	Embankment in Place	CY	1,111	$20.00	$22,222.22
3040504	Type 5 Aggregate for Base (4" Thick)	SY	267	$6.00	$1,600.00
4011209	Bituminous Pavement Mix PG64-22 (BP-1) (Surface Course) (2" Thick)	SY	31	$100.00	$3,060.00
4020520	Bituminous Pavement Mix PG64-22 (Base) (Two 3" Lifts)	TONS	90	$90.00	$8,100.00
6062301A	Transition Section, 7.5 Ft. Posts	EA	4	$800.00	$3,200.00
6062401	Bridge Anchor Section	EA	4	$2,000.00	$8,000.00
6063015	Type A Crashworthy Terminal End Section	EA	4	$2,500.00	$10,000.00
6161005	Construction Signs	SF	97	$12.00	$1,164.00
6161030	Type III Moveable Barricade with Light	EA	4	$350.00	$1,400.00
6181000	Mobilization	LS	1	$25,000.00	$25,000.00
8051000A	Seeding - Cool Season Mixtures	AC	0.5	$4,000.00	$2,000.00
8061019	Silt Fence	LF	400	$3.00	$1,200.00
	Sub-Total Roadway Items				**$96,941.22**
2061000	Excavation for Structure Class 1	CY	133	$50.00	$6,666.67
2160500	Removal of Bridges	EA	1	$30,000.00	$30,000.00
5031010	Bridge Approach Slab	SY	107	$250.00	$26,666.67
6113020	Furnishing Type 2 Rock Blanket	CY	89	$30.00	$2,666.67
6113040	Placing Type 2 Rock Blanket	CY	89	$30.00	$2,666.67
6240103A	Geotextile (Type 3) Class A	SY	133	$4.00	$533.33
7027000	Pile Point Reinforcement	EA	8	$150.00	$1,200.00
7021010	Structural Steel Piles (10 in.)	LF	120	$85.00	$10,200.00
7034003	Class B1 Concrete (Substructure)	CY	73.3	$600.00	$43,980.00
7034221	Class B1 Concrete (Superstructure)	CY	26.7	$1,000.00	$26,685.19
7056022	24" Prestressed Concrete Voided Slab Girder	LF	364	$250.00	$91,000.00
7101000	Reinforcing Steel (Epoxy Coated)(Grade 60)	LB	7,500	$1.75	$13,125.00
7135000	Concrete Safety Barrier Curb	LF	110	$120.00	$13,200.00
7161000	Plain Neoprene Bearing Pads	EA	14	$120.00	$1,680.00
	Sub-Total Bridge Items				**$270,270.19**
				Construction Total =	**$367,211.41**
				Contingencies at 10% =	**$36,721.14**
				Design Engineering =	**$60,589.88**
				Construction Inspection & Testing =	**$24,235.95**
				Project Total =	**$488,758.38**