Michigan Department of Transportation
Historic Bridge Inventory Update

 

NBI_Bridge_ID # 08108012000B020 **Structure #:** 529 **County:** BARRY

NR Recommendation: Eligible **City:** CARLTON TWP

MDOT Region: 5- SOUTHWEST **Owner:** MDOT

Location: 6.2 MI W OF WOODLAND **Milepoint:** 3

Feature On: M-43

Feature Intersected: COLDWATER RIVER

Type: BOX BEAM **Design:** ADJACENT

Material: PRESTRESSED CONCRETE

Railing Type: MSHD R-4 CONCRETE POST & OPEN METAL PANEL RAILINGS

 # Spans: 3 **Overall Length (ft):** 135 **Deck Width (ft):** 36.4

Year Built: 1956 **Alteration (Date):** **Source:** PLAQUE

Designer/Builder: MI STATE HWY DEPT

Setting/Context:

RURAL

Physical Description:

The skewed, 3 span, 135'-long, adjacent prestressed concrete box beam bridge is supported on concrete abutments with stepped wingwalls and bents with horizontally scored cap beams and web walls. The spans are 45' long and made up of 27" deep beams. The bridge is finished with MSHD R-4 railings.

Summary of Significance:

The 1956 adjacent box beam bridge is historically and technologically significant as one of the earliest extant prestressed concrete bridges built by the Michigan State Highway Department (MSHD). Use of prestressed concrete for bridges was the single most important technological advance in bridge design during the last half of the 20th century, so much so that by 1986 it, not steel, was Michigan's preferred bridge material. This bridge marks Michigan's move to the new technology, albeit later than the national leader states like Pennsylvania, Florida, and Illinois and some counties and cities in Michigan. The MSHD demonstrated an interest in prestressed concrete, but it took a measured approach of examining efforts in other states in the early to mid 1950s, then conservatively adopting beam designs and specifications developed by federal engineers from 1952 to 1956 and approved by the American Association of State Highway Officials (AASHO) in 1956. Michigan was a steel bridge state, and the department leadership was trained and well-versed in its use. Ironically, it was steel delivery delays that forced the state to turn to the new material in order to maintain construction schedules. Michigan was fortunate to have two capable fabricators, Lamar Pipe and Tile Company of Grand Rapids and Superior Products Company of Detroit, that promoted the product and worked with clients to either design or advise on designs. The ready availability of prestressed concrete units made them competitive with steel. But despite the advantages of prestressed concrete units, it was still a challenge to unseat steel or reinforced concrete as the material of choice by the MSHD. The Coldwater River bridge marks the beginning of that evolution.

Credit goes to Lamar Pipe & Tile Company of Grand Rapids, which, under the leadership of plant manager J. W. Corson, headed the effort to bring precast, prestressed concrete bridges to Michigan. Lamar was established in 1923 to produce concrete and terra-cotta pipes for sanitary and drainage systems. It was acquired in 1954 by American-Marietta Company, the largest concrete pipe manufacturer in the country. Corson, who recognized the potential of prestressed concrete, encouraged American-Marietta to acquire Concrete Products Company of America, the company that developed the prestressed concrete box beam in 1949-50. American-Marietta now had the license for the prestressed concrete voided beam, and Lamar immediately constructed a casting yard at its Grand Rapids facility based on the layout of Concrete Products's yard in Pottstown, Pennsylvania. As both bridge designer and salesman, Lamar worked to educate potential clients about their new product, illustrating its strength, economy, and ease of construction, especially in poor weather conditions when cast-in-place concrete was impractical.

The voided box beam bridge type was developed by Concrete Products Company of America in 1949-50. The company was associated with construction of America's first prestressed concrete bridge, the 1949-51 Walnut Lane bridge at Philadelphia. It was looking for a way to increase the capacity of the channel beam, a precast reinforced concrete unit that was being used with great frequency on secondary roads after World War II. By enclosing the C-shaped channel beam into a box shape and then applying the new reinforcing system of prestressing with seven-strand wire developed by John A. Roebling's Sons, they came up with the 17" and 21"-deep precast hollow box beam that is longer and stronger than the channel beam. One of the keys features of their design was using cylindrical cardboard sono-tubes to form the voids. Concrete Products worked with the Pennsylvania State Highway Department, which placed its first adjacent box beam bridges late in 1950. While other engineers also produced different prestressed beam designs, it was the voided box beam developed by Concrete Products and produced in Michigan under their license starting in 1954 that came to be one of the dominant beam designs during the last half of the 20th century.

Reviewed By: LCE (7/07)

Notes:

Historic Property Adverse Effect

What is the history of the bridge? The M-43 bridge over the Coldwater River was built in 1956-1957 and was one of the first examples of a new technology at the time, prestressed concrete beams. These beams were developed in the late 1940s and many other states across the country were starting to use prestressed concrete for their bridges. MDOT (then the Michigan State Highway Department) tried the new technology because it was experiencing delays in purchasing steel. Like steel, prestressed concrete beams are strong and relatively easy to install. Prestressed concrete beams were so successful that hundreds of similar bridges have been built across Michigan. This bridge was built by the L. W. Lamb Co., who won the contract with a low bid of $115,715.

What is an adverse effect? The M-43 bridge over the Coldwater River is eligible for listing on the National Register of Historic Places. To comply with the National Historic Preservation Act, the impacts of the proposed replacement were reviewed by the State Historic Preservation Office. Planned bridge replacement involves demolishing the existing structure and is an "adverse effect" under the law. The bridge replacement will also have an impact under Section 4(f) of the Department of Transportation Act. MDOT looked at all options to rehabilitate or fix the existing bridge, but unfortunately rehabilitation will not address the deterioration.

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Mitigation for the Adverse Effect

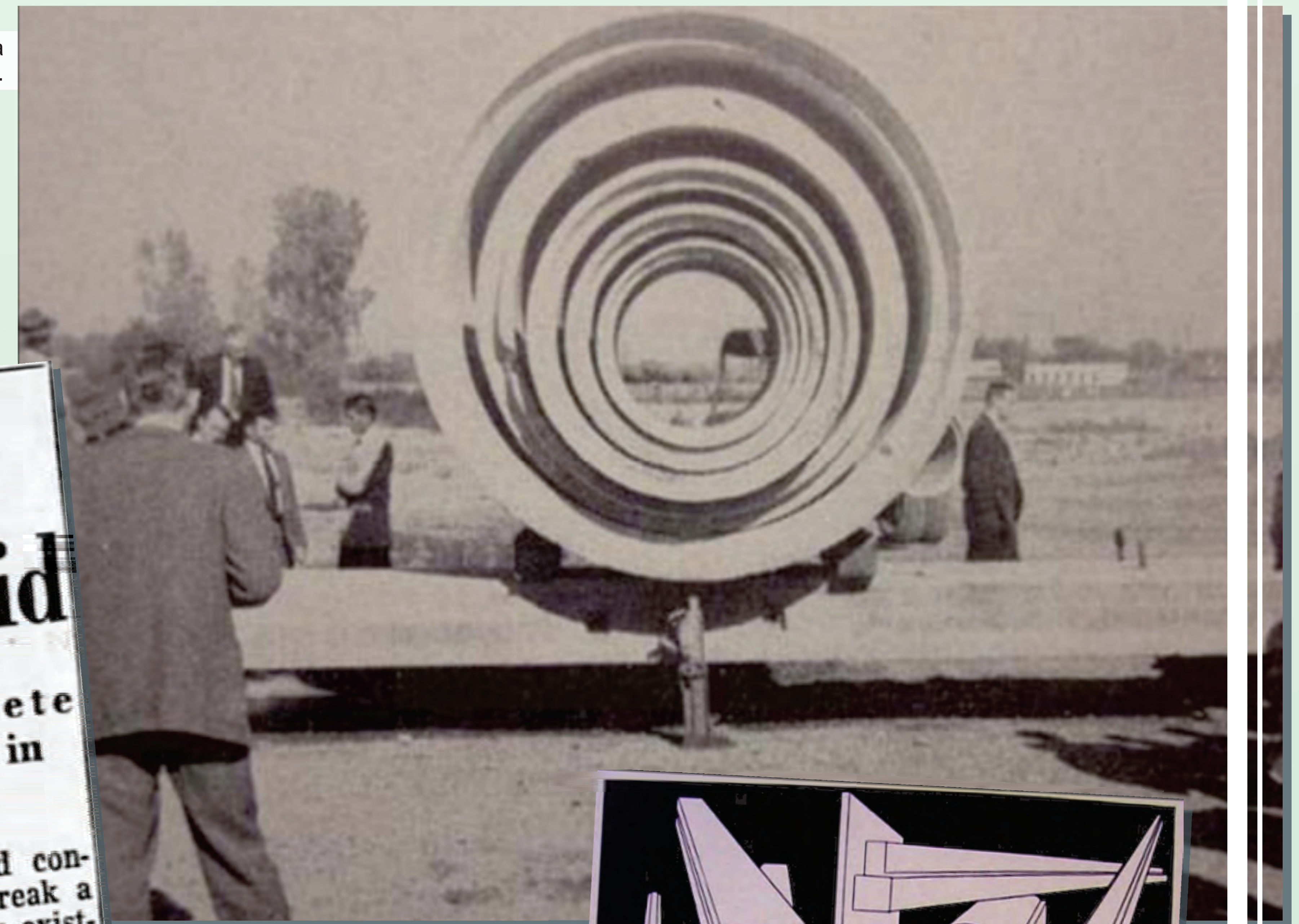
The National Historic Preservation Act outlines how to resolve adverse effects on historic properties. Part of the adverse effect resolution process is to find appropriate mitigation. Mitigation is softening, moderating, or alleviating the negative impact from the project. For the proposed bridge replacement, the adverse effect is due to the demolition of the structure.

What can be done to mitigate that impact?
Two suggestions are:

1. Record the existing bridge with photographs that will be archived.
2. Develop an online brochure about the history of prestressed concrete in bridge construction.

Do you have any mitigation ideas?
Write down your suggestions on a sticky note and post it below:

1954, Test of a prestressed concrete beam.



Dec. 14, 1957 Lansing State Journal article.

New Beam Seen Aid

Pre-Stressed Concrete Breaks Bottleneck in Road Work

The use of pre-stressed concrete beams is helping break a bottleneck that previously existed in highway bridge building, the state highway department reported Saturday.

Delays in opening trunklines because of waits for structural steel on bridge and grade separations may be a thing of the past because of such use, said John C. Mackie, state highway commissioner.

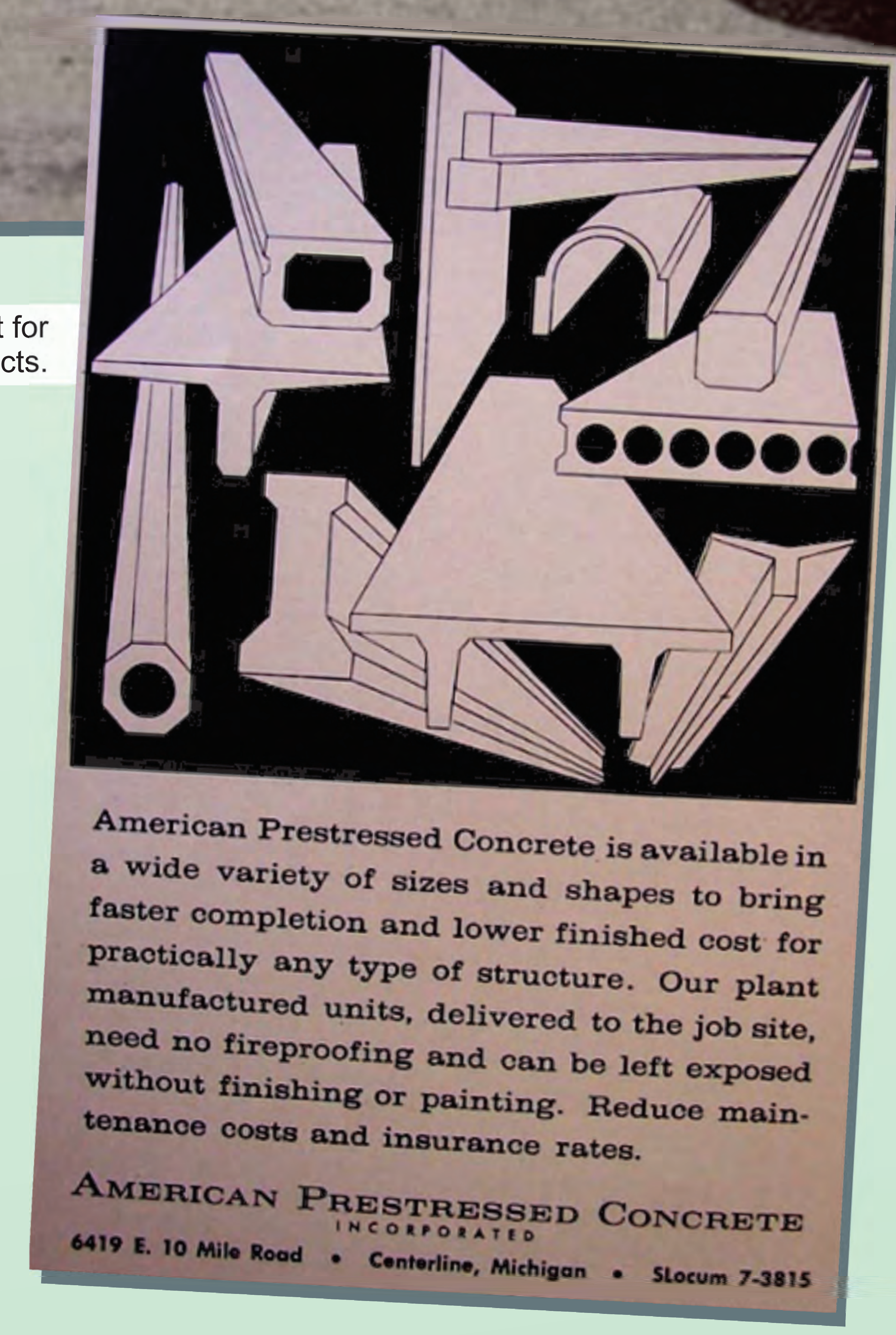
CABLE-REINFORCED

The pre-stressed concrete beams, highway engineers explained, are made by pouring concrete into a box - shaped mold with a hollow center. From 16 to 25 steel cables are enclosed in the concrete when it is poured to reinforce the concrete beam.

The advantage of the concrete beam, it was explained, is speedy delivery with costs comparable to steel construction. A number of firms in Michigan now manufacture this type of beams.

The highway department reported that nine bridges using the concrete beams are presently in use in Michigan and eight are currently under construction.

1961, Advertisement for prestressed concrete products.



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JN 204337 M-43 Coldwater River Bridge Condition Report, Rehabilitation Assessment, and Photos

The structure was built in 1956 utilizing side-by-side prestressed concrete box beams in the superstructure supported by abutments on timber piles that are approximately 23 feet long. The piers are supported on spread footing foundations. The structure is 135 feet long with a clear roadway with of 30 feet that accommodates two 12-foot lanes and two 3-foot shoulders.

Condition Report:
The current structure rating is 3, which means it is in serious condition. This rating was assigned because of the following deficiencies/issues:

- Side-by-side concrete box beams have scattered longitudinal cracks and spalling.
- At least 5 beams have multiple broken strands (main reinforcement) and exposed strands. One of the beams, as an example, has 6 broken strands at different locations and another 2 exposed strands. The broken strands cannot be fixed or repaired and the load carrying capacity has been reduced, resulting in a serious deficiency for the overall structure.
- Bridge surface is in poor condition.
- Abutments have significant delamination and at some locations under the beams, which in turn is affecting the bearing area of those beams.
- Pier caps have approximately 50% of the entire length spalled or delaminated with scattered delamination to the pier walls. In addition, the pier columns have cracks and delaminated areas with some locations exhibiting exposed reinforcement. There are also delaminated areas and cracks that were observed on the pier walls.
- Structure has been rated as scour critical due to the pier spread footing foundations and the short length of the timber piles at the abutments.
- Steel panel bridge railing with concrete posts and a thrie beam retrofit has some deficiencies. Most of the concrete posts have cracks and the brush block has extensive cracks with the north railing brush block having approximately 70% of its area with spalled and delaminated areas and exposed reinforcement.
- Undermining at the channel banks.

Rehabilitation Assessment:

- The broken strands in the concrete box beams cannot be fixed as the prestressed steel is embedded in the concrete beams. Once a strand is broken, that reinforcement is no longer effective, and this in turn affects the load carrying capacity of the beam and the entire structure.
- Doing nothing would result in increasingly diminished load-carrying capacity as other beam strands break and eventual closure of the bridge to all traffic. Research has shown adjacent box beams have an average life span of 55 years in Michigan and this bridge is currently 65 years old, so strands will continue to break over time. There is also no way to armor the bridge piers from scour. Maintenance cannot correct the broken strands or lack of scour protection.
- Building on a new location while leaving the existing bridge in place would not address the structural deficiencies and lack of scour protection. As noted below, rehabilitation to

address the structural deficiencies and scour will result in the physical demolition of most of the bridge.

- To rehabilitate the bridge would require the replacement of all beams with broken strands. In order to replace the beams, the entire superstructure (everything above the abutments and piers) will require removal to access the beams. Rehabilitation would therefore result in the physical destruction of much of the bridge. The historic integrity of the bridge would be lost as a result of any rehabilitation project.
- The piers are in poor enough condition that a rehabilitation could not address them sufficiently. In addition, while currently there is little known scour at the bridge piers, rehabilitation would require the installation of micropiles to address any future scour and work on the abutments as well. Micropiles cannot be installed in the piers without removing the superstructure due to the lack of headroom.

Photos:

Photo 1—North elevation of the bridge.

Photo 2—South elevation of the bridge.

Photo 3—East elevation of the east pier.

Photo 4—Detail of the underside of the bridge showing a broken and exposed beam reinforcing strand.

Photo 5—Fascia at the north elevation of the west pier.

Photo 5—North railing and spalled brush block.