Brooks Aqueduct – A Quick Overview

- As final payment for the construction of the national railway, the Canadian Pacific Railway (CPR) was given 3 million acres of land between Medicine Hat and Calgary. To encourage settlement of the desert-like land, the CPR developed an irrigation system.
- A valley, two miles wide and sixty feet deep, prevented irrigation of the area northeast of Brooks. The CPR built the Brooks Aqueduct across this valley, pushing the limits of engineering technologies of that time.
  - constructed from 1912-1914, it was the first aqueduct in the world to use the hydrostatic catenary design (the natural shape a flexible material would take when suspended between two level supports and filled with water)
  - largest steel reinforced concrete aqueduct in North America, possibly the world
  - longest aqueduct yet constructed to carry such a large volume of water
  - siphon passes under the railway
- There were many challenges during the design construction of the aqueduct.
  - as many as 300 men worked on the construction of the aqueduct at peak summer times
  - water had to be brought in by train from Suffield (40 miles to the east)
  - gravel was brought in by train from Keith (140 miles to the west)
- The untested engineering technologies faced challenges within a year of the first water going through the aqueduct.
  - maximum flow rate achieved by aqueduct only about two thirds of the design capacity
    - small drop in elevation over the valley hindered a greater flow rate and allowed greater aquatic growth which also slowed the flow of water
    - cross-struts across the top of the aqueduct also created a backwash which slowed the flow
    - fish weren't considered in the optimistic flow rate; fish going through the aqueduct also slowed the flow
  - alkali deteriorated the concrete; another reinforced concrete structure, the Antelope Creek Syphon, was completely destroyed by alkali
  - effects of frost on concrete were not well understood then
- In spite of these challenges, the Brooks Aqueduct delivered an enormous amount of water to farmers northeast of Brooks for 65 years. In 1914 there was no other structure like it, and that is probably still true today.
- It was replaced by a more efficient earthen canal in 1979.

Notes from Various Reports

- Carried water to “as much as a third of the irrigated land in the District” (Finch, 1993, p. 4).
- “The CPR chose an unusual design, the hydrostatic catenary, for the Brooks Aqueduct location. Although used elsewhere, it differed from those applications in two significant ways. First, other hydrostatic catenary flumes used steel in their shells but the CPR used concrete in this application. Other flumes were supported from below and not suspended like the Brooks Aqueduct” (Finch, 1993, p. 7).
  - “… the decision by the CPR to use the hydrostatic catenary curve in a suspended, reinforced concrete shell design was a new combination of principles untried in an aqueduct application” (Finch, 1988, p. 38).
  - “It represented a landmark in civil engineering as it was the first aqueduct in the world to utilize the hydrostatic catenary shape for the water section and was the longest aqueduct yet constructed to carry such a large volume of water. Water commenced in the spring of 1912, utilizing a total of 38 construction crews and close to 300 men over a span of the next two and a half years” (Doucet, 1989, p. 1).
  - “hydrostatic catenary – the shape the water would assume in a flume running full if a flexible material was used for the barrel” (Babcock, 1979, p. 2).
  - “It was the first aqueduct in the world to utilize the hydrostatic catenary for the shape of the water section, and it was the longest aqueduct yet constructed to carry such a large volume of water – virtually an overhead river running at better than seven feet per second” (Babcock, 1979, p. 2).
- “As the author of the history of professional engineering in Canada wrote, reinforced concrete was ‘a material regarded with some suspicion’ at the time of the construction of the Brooks Aqueduct” (Finch, 1993, p. 9).
- “The destructive action of frost on concrete was not well understood in the early years of the aqueduct’s life” (Finch, 1993, p. 39).
- “Even though plagued by design, construction, operations and maintenance flaws, it carried an enormous amount of water to farmers economically for 65 years without major failure” (Finch, 1993, p. 40).
- Few written accounts of the construction of the aqueduct were recorded.
  - “This is probably due to the fact that the CPR experienced numerous difficulties with contractors during construction – in fact the ‘old-timers’ often stated there were always three contractors involved – ‘one on the site, another coming and another going” (White, 1983, p. 1).
- In 1935, “… there was a great deal of anxiety expressed by some of the farmers that the Aqueduct could break the new District. The structure was referred to by these people as a gigantic ‘White Elephant’” (White, 1983, p. 2).

- "The largest steel reinforced concrete aqueduct in North America, possibly the world" (Caligiuri, 1983, p. 5).
- "By July 6, 1979, when the structure was abandoned, approximately 55 per cent of the lower portion of the barrel had been replaced" (Caligiuri, 1983, p. 15).
- "…the aqueduct is a symbol of the challenges faced by the early pioneers and their persistence to overcome obstacles and make irrigation farming a viable and prosperous agricultural enterprise in Western Canada" (Caligiuri, 1983, p. 21).
- During construction, "work was hampered by a lack of water and gravel. A reservoir was constructed alongside" the railway tracks built along the line of the aqueduct and "six water-cars brought 30,000 gallons of water each day from Suffield. Gravel was also shipped in on a regular basis" (Corbet, 1987, p. 13).
    - "Washed gravel came from Keith, 140 miles (225 km) west on the railway and was shipped in cars" (Finch, 1993, p. 21).
- A ¾ scale model of the flume portion of the Brooks Aqueduct was built on benchland overlooking the Bassano Dam (Manz, Loov, & Webber, 1988, p. 12).
- The maximum flow rate achieved by the aqueduct was only about two thirds of the design capacity (Manz, Loov, & Webber, 1988, p. 13)
    - "Either it was in error or a friction value excessively low was used" (Finch, 1988, p. 3).
    - "Fish, friction and cross-strut factors ensured that the Brooks Aqueduct could never deliver 913 c.f.s." (Finch, 1988, p. 80).
    - Not enough of a drop in elevation to "promote a high velocity in the flow. Also, according to one study, a slope of anything less than 0.02% allows too much aquatic growth to build up in the channel and further reduces the speed of the water" (Finch, 1993, p. 28).
    - After many alterations, the aqueduct exceeded 700 c.f.s, never the 913 c.f.s "promised by the original engineers" (Finch, 1993, p. 29).
- "…the strict definition of "aqueduct" does not include the Brooks Aqueduct at all since it is open at the top, and therefore more accurately called a flume" (Finch, 1988, p. 14).
- "Above all, the Brooks Aqueduct is a major testimony to the ability of a group of people to triumph over a natural obstacle and bring tens of thousands of acres of near-desert into irrigation" (Finch, 1988, p. 31).
- At the time of its construction, the Brooks Aqueduct was "the largest steel reinforced concrete aqueduct in North America, possibly in the world" (Finch, 1988, p. 14).
- Although "other aqueducts carried more water over short distances, the Brooks Aqueduct was the longest aqueduct to carry this quantity of water" (Finch, 1988, p. 31).
- "Although the composition of the cement itself also caused problems, this leap into an unknown area of stress and elasticity of a new material, suspended reinforced concrete, was apparently based on untried engineering assumptions. Only the story of 65 years of maintenance which is recounted below fully explains how this pivotal, educated guess affected the financial viability of the Brooks Aqueduct" (Finch, 1988, p. 39).

- Constructed from 1912-1914; Original cost - $569,287 (Finch, 1988, p. 50)
- At peak summer periods, as many as 300 men were employed on the project (Finch, 1988, p. 51).
- The Engineer in Charge, Gibb, stated that progress was recorded daily and weekly progress photographs were also taken, yet "these detailed records and photographs have not survived" (Finch, 1988, p. 61-62).
- Some criticism of the Aqueduct at the time it was built may have been biased since the Canadian Pacific Railway was not held in high esteem. Locals referred to the railway company as the "Canadian Pathetic" (Finch, 1988, p. 64).
    - Also, the street of CPR houses in Brooks was referred to as "rotten row."
- "Two years before it was replaced a section, seven or eight feet across, fell out and began dumping water from the flume to the ground below" (Finch, 1988, p. 109).
- "…the minimal drop in altitude between the reservoir and the eastern side of the river valley allowed only a five foot loss of elevation" (Finch, 1988, p. 112).
- "…the fact remains that the aqueduct worked for 65 years" (Finch, 1988, p. 112).
- "…the aqueduct pushed the limits of numerous aspects of technology at the time of its construction" (Finch, 1988, p. 112).
- Another reinforced concrete structure, the Antelope Creek Syphon was destroyed by the "destructive forces of alkali" (Finch, 1988, p. 82-87,113).
- "During the peak of the construction in 1914, the daily progress made was approximately 25 m" (ISL, 2016, p. 2).
- The flume is "supported by 1030 reinforced concrete columns resting on pedestals sunk 7 feet into the ground (Doucet, 1989, p. 1).
- Maximum height – 61 feet; average height 25 feet (Doucet, 1989, p. 1).
- 136,370 liters of water was required every day for mixing the concrete. "The water was hauled by special train from Suffield, 40 miles to the east" (Doucet, 1989, p. 1).
- "The columns and girders were put up at the rate of 100 feet per day while the concrete shell progressed at the rate of 800 feet per week" (Doucet, 1989, p. 1).
- There are different accounts of the cost of building the aqueduct. They vary from $569,287 - $700,000 (Doucet, 1989, p. 2).
- Concrete began deteriorating in 1918, followed by needing annual repairs (Doucet, 1989, p. 2).
- Replaced with "a less spectacular, but much more efficient, earthen canal" in 1979; 65 years after the aqueduct was completed (Doucet, 1989, p. 2).
- 400 feet of the aqueduct was removed for the construction of a county road (Doucet, 1989, p. 2).
- Declared a National Historic Site in 1983 (Doucet, 1989, p. 3).
- "Water delivery from Lake Newell to the area NE of Brooks was contingent on the construction of a large flume or aqueduct to span a valley NE of Newell Lake" (Babcock, 1977, p. 1)

- “A special feature of the aqueduct is the siphon which passes under the main line of the C.P.R.” (Babcock, 1977, p. 2)
- “Mr. White described the aqueduct as a designer’s dream but an operator’s nightmare: although rated to deliver 900 cubic feet of water per second, he has not seen it exceed 640 cubic feet per second. This, added to the prohibitive cost of maintaining the structure, had made it obsolete” (Babcock, 1977, p. 2)
- “Not only was the land opened up for settlement, it was transformed from arid rangeland to productive farmland through the gift of water” (Babcock, 1977, p. 4)
- “In order to irrigate 135,000 acres of the District northeast of Brooks, water from Lake Newell had to be conveyed across a shallow valley lying 2.5 miles northeast of the lake. It was necessary to move 900 cubic feet of water per second across the valley two miles wide and sixty feet deep, to lose as little head or elevation as possible – less than five feet in two miles – and to do so economically” (Babcock, 1979, p. 2).
- “In 1914 there was no other structure exactly like it anywhere, and that is probably still the case today” (Babcock, 1979, p. 3).
- 4 wells were drilled for water, but not enough water was found so a reservoir alongside the railway track was built to hold 150,000 gallons of water, “and a water-train of six water-cars delivered 30,000 gallons per day, brought from Suffield, about 40 miles away” (Gibb, 1915, p. 453).
- “Railway sidings were built near the crossing, storehouses for cement and other material erected and a concrete-lined reservoir for water was constructed. A double-track, standard gage railway, with frequent crossovers, was built along the line of the work on the south side, and a pipe leading from the reservoir to an elevated tank at the west end of the structure laid down with taps at frequent intervals” (Muckleston, 1915, 62).
- “The siphon is an inverted reinforced steel concrete pipe that operates on the Venturi Principle. It was built to a depth of 40 feet underneath the tracks and narrows in the middle to increase the pressure on the water passing through. The siphon loses only 3 inches of head on the far side” (StarWorks, 1996, para. 2).

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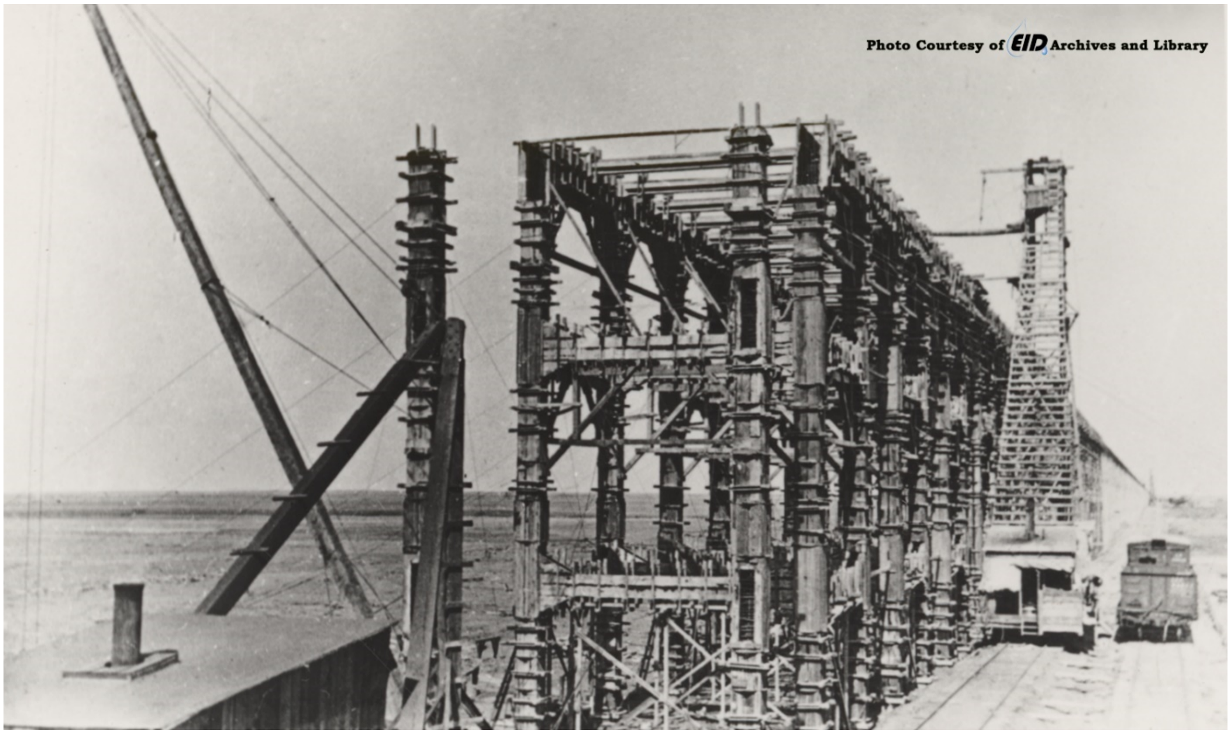
Photos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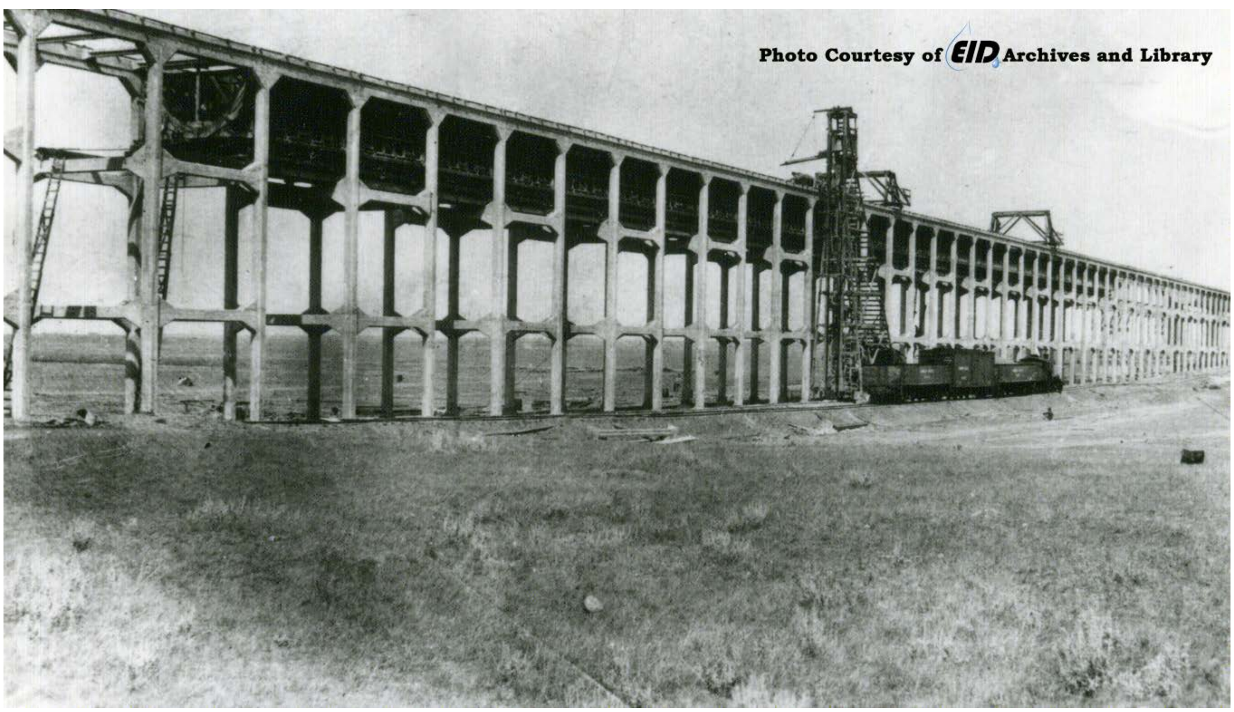
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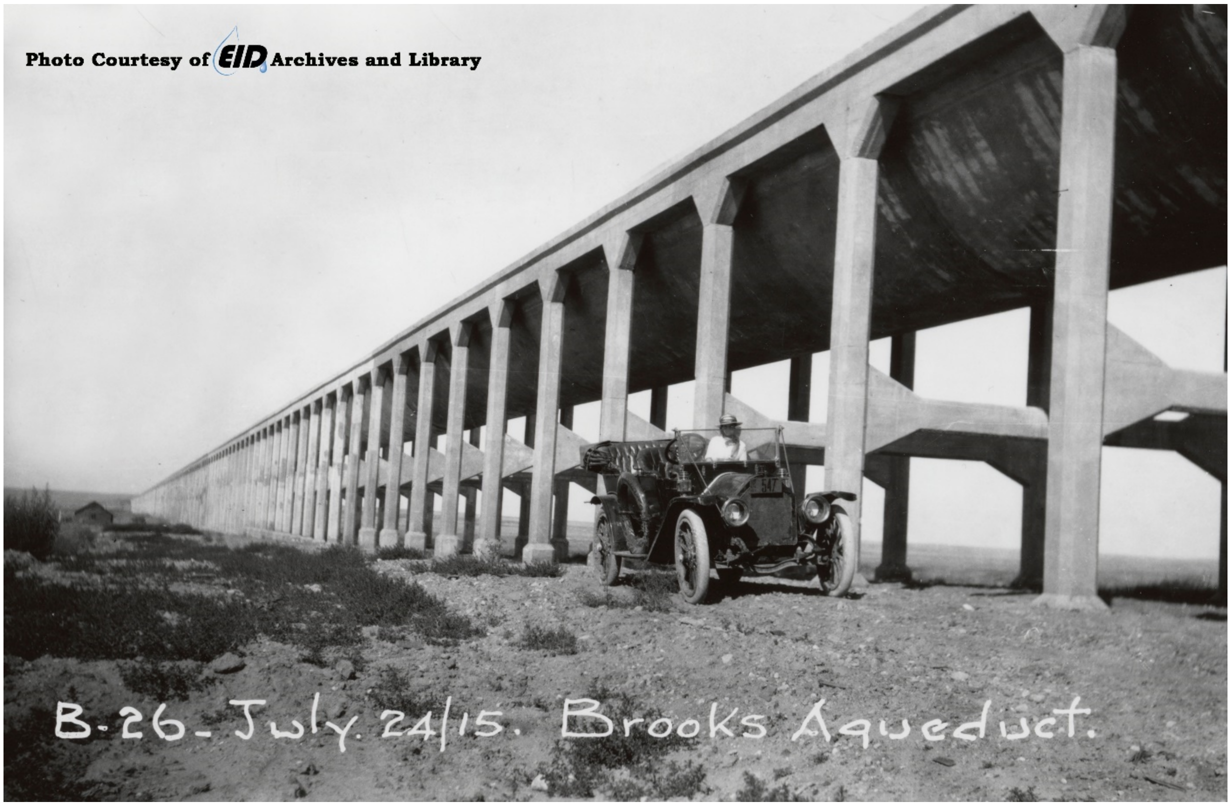
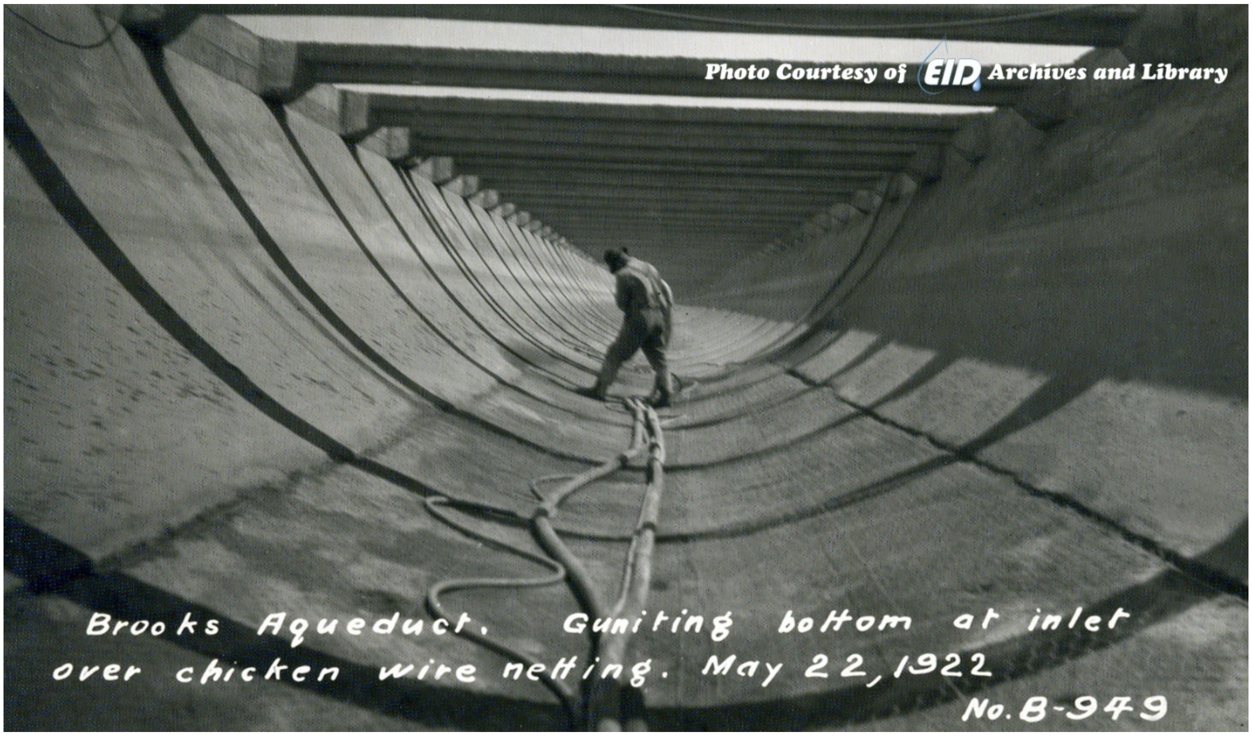


B-26- July 24/15. Brooks Aqueduct.

B.113. May '17. Pedestal #344. Brooks Aqueduct.


Photo Courtesy of EID Archives and Library


BROOKS AQUEDUCT, Columns 417-419. MAY 4, 1921
Poor concrete removed from bottom
No. B-664
Photo Courtesy of EID Archives and Library



Brooks Aqueduct. Guniting bottom at inlet over chicken wire netting. May 22, 1922
No. B-949

Removing aquatic growth at Aqueduct Syphon
July 4, 1922
B-1025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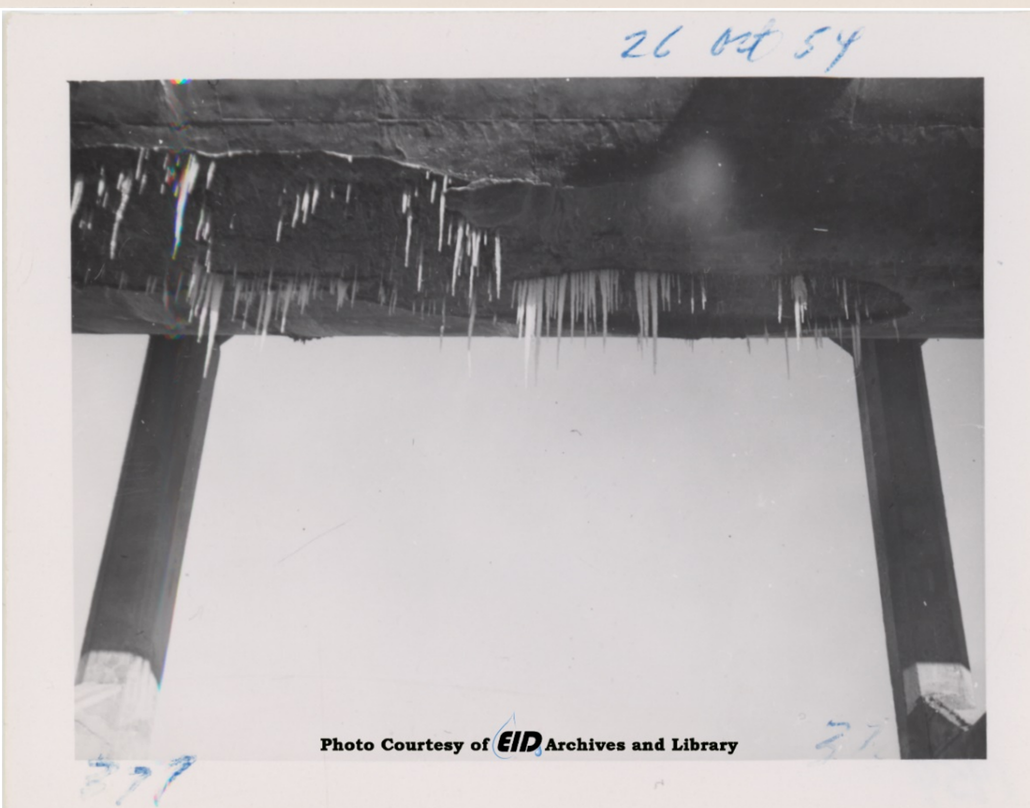
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September 4, 2019

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September 4, 2019