LOWER LAKE GIRARD DAM

THE BREACHING OF AN AMBURSEN DAM

GIRARD, OHIO

by Brian H. Greene
PRESENTATION OUTLINE

• PROJECT FEATURES

• GEOLOGIC SETTING

• PROJECT HISTORY

• PRIOR AMBURSEN DAM FAILURES & SUCCESSES

• DAM SAFETY & STABILIZATION PROPOSALS

• 2008 BREACHING OF DAM
• Concrete slab buttress section

• Earthen Embankment on right side

• Concrete overflow spillway on rock on left side

• Impoundment of Squaw Creek formed Liberty Lake
PROJECT FEATURES

• THE STRUCTURE IS A SLAB BUTTRESS DAM BUILT IN 1917.

• THE CONCRETE SECTION OF THE DAM HAS A MAXIMUM HEIGHT OF 43 FEET ABOVE ITS FOUNDATION AND A LENGTH OF 436 FEET.

• AN EARTHEN SECTION CONSTITUTES THE RIGHT SIDE OF THE DAM, AND THERE IS AN OVERFLOW SPILLWAY ON ROCK ON THE LEFT SIDE. TOTAL DAM LENGTH IS ABOUT 1,100 FEET.

• THE 55 ACRE LAKE FORMED BY THE DAM DRAINED AN AREA OF 17.2 SQUARE MILES.

• WHEN IN OPERATION, MAXIMUM DISCHARGE WAS 6900 cfs
Buttressed dam

Section A-A

Section Elevation

Reinf. conc. structure

H.W.L 1.5m

0.45m

1.1

2m

(Buttressed dam)
SITE GEOLOGY

**SITE**

**GEOLOGY**

- **Top of embankment**
- **Glacial till and outwash**
- **No rock**
- **Buried valley?**
- **Top of bedrock (approx.)**
- **Sandstones and shales, some conglomerate**
- **Spillway on bedrock**

- **El. 980**
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PROJECT HISTORY

• DAM WAS BUILT IN 1917 BY THE AMBURSEN HYDRAULIC CONSTRUCTION COMPANY OF BOSTON, MASS TO SUPPORT THE INDUSTRIAL NEEDS OF YOUNGSTOWN, OHIO AND THE MAHONING VALLEY.

• IT WAS LATER PURCHASED BY THE CITY OF GIRARD IN 1995 FROM THE OHIO WATER SERVICE CO. TO BE USED FOR CITY WATER SUPPLY AND RECREATIONAL FISHING.

• AS OF 1920, OVER 70 AMBURSEN SLAB BUTTRESS TYPE DAMS HAD BEEN BUILT OVER THE U.S. AND CANADA. THREE, INCLUDING LOWER LAKE GIRARD DAM, REMAIN IN OHIO.

• GIRARD DAM SURVIVED OVER 90 YEARS, HOWEVER NOT ALL AMBURSON DAMS BUILT AFTER 1900 WERE SUCCESSFUL.
ASHLEY DAM, MA (backward erosion of foundation)

- 40 ft high slab and buttress dam.
- Dam was undermined in 1909 after heavy rains.
- Reservoir emptied in less than an hour leaving a large gap at its base. Indications that the cut off was not taken to bedrock.
- The crest of the dam sagged a few feet. Dam was repaired and returned to service.
STONY RIVER DAM, WV (piping)

- 50 ft high slab and buttress dam failed in 1914, only 6 months after the reservoir was impounded.

- Slow leakage noted under dam.

- Reservoir emptied slowly followed by a blow out of 5 bays at a location where the upstream slab cut off had not been taken into bedrock.
ROCK RUN DAM, PA

• 42 ft high slab and buttress dam located in eastern PA.

• The dam was constructed in 1917 and had very few repairs. Upstream slab was cracked with severe concrete deterioration.

• In 1999, rehabilitation of the dam involved filling the critical east bays with concrete and installing a micropile foundation.

From November 2001 issue of CIVIL ENGINEERING magazine. Three co-authors were from, and design done by: the Valley Forge, PA office of Gannett Fleming, Inc.
Lower Lake Girard Dam Foundation

• The concrete section of the dam successfully impounded a reservoir for over 90 years without incident for 2 key reasons:

1. The upstream cut off was properly embedded in rock forming an effective seepage cut off.

2. Downstream buttresses were also taken to rock, thus there was an effective load transfer from the slab – to the buttresses – to the downstream footers – and into bedrock.
There were a number of factors that led to the decision to either repair or breach the dam.

Key Dam Safety concerns were:

1. The downstream buttresses of the concrete section had severely weathered and there was exposed rebar.

2. The spillway was deemed inadequate and could not effectively pass the PMF without spilling over the dam – either the concrete section or earthen section, resulting in failure.

3. Outlet pipes were inadequate to pass inflow in the event of a peak storm.
DAM SAFETY & STABILIZATION

• The Corps of Engineers was authorized by Congress to undertake a study of rehabilitation of this non-Federal dam (championed by the flamboyant Congressman Traficant of Ohio).

• The Corps study resulted in a design with plans & specifications to rehabilitate the dam by filling the bays with concrete.

• Problem was that the repair cost was estimated at $16 million and the congressman was imprisoned on Federal corruption charges in 2002. Thus, no further work leading to repairs progressed.

• ODNR Dam Safety issued an order to the City of Girard to either repair, breach, or remove the dam. In late 2007, the decision was made to breach the dam as this was the least costly alternative.
PRE BREACH LOWER GIRARD DAM (2005)
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DAM SAFETY & STABILIZATION

• Scassa Aggregate & Asphalt, Inc., a local Ohio company was hired to breach the dam for $139,000. All work was completed in August 2008.

• Breaching consisted of cutting ten - 10 ft by 15 ft openings into the lower upstream slab of the dam permitting a run of river condition. A diamond saw was used to cut the “window” openings through the 2 feet thick upstream slab.
2008 BREACHING OF LOWER GIRARD DAM
2008 BREACHING OF LOWER GIRARD DAM
POST BREACH LOWER GIRARD DAM

- View of downstream buttresses
- Looking at breach slots from downstream to upstream perspective
- Note - no flow
LOWER GIRARD DAM – Sept 3, 2011
After the 10 windows were cut into the inclined upstream slab, Squaw Creek was in a “run of river condition”.

Fertile bottom sediments promoted rapid growth of vegetation.
REVEGITATED RESERVOIR BED
CONCLUSIONS

• FULLY REHABILITATING AMBURSEN DAMS CAN BE COST PROHIBITIVE AND LOCAL OWNERS OFTEN CAN NOT AFFORD THE WORK.

• THOSE REHABILITATIONS THAT HAVE BEEN SUCCESSFUL INVOLVE TRANSFORMING THE SLAB / BUTTRESS DAM INTO A GRAVITY DAM STRUCTURE BY FILLING THE BAYS WITH CONCRETE COUPLED WITH FOUNDATION WORK.

• IN THE CASE OF LOWER LAKE GIRARD DAM, BREACHING WAS THE ONLY FEASIBLE SOLUTION THAT WOULD INSURE DAM SAFETY AND PROTECT DOWNSTREAM RESIDENTS.

• KEY TAKAways OF BREACHING AN AMBURSEN DAM:
  – COST EFFECTIVE
  – SHORT CONSTRUCTION DURATION
  – NEED TO INVOLVE ALL STAKEHOLDERS – ESPECIALLY ENVIRONMENTAL
Acknowledgements

• City of Girard, Ohio

• Ohio Dept of Natural Resources - Dam Safety

• U.S. Army Corps of Engineers, Pittsburgh
THANK YOU!