SUMMARY OF HYDRAULICS BRANCH PARTICIPATION IN UNDERWATER CANAL LINING STUDY

by

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MS-884 (10-85)
Bureau of Reclamation

D-3752

UNITED STATES GOVERNMENT

memorandum

Memorandum

TO : Jackie E. Johnson, Water Conveyance Branch

Denver, Colorado
DATE: April 20, 1989

FOR

FROM : Clifford A. Pugh, Head, Hydraulic Equipment Section

SUBJECT: Summary of Hydraulics Branch Participation in Underwater Canal Lining Study (Hydraulic Research)

The Hydraulics Branch was involved in several aspects of the overall research program including:

1. Erosion studies in our 4-ft-wide permanent flume and in a smaller portable flume to determine the erosive characteristics of the fresh concrete under flowing water.

2. Mathematical simulation of flow in the Coachella Canal to determine velocities near the slipform when the concrete is being placed in the actual canal.

3. Design, construction and operation of a 1 to 3 demonstration model, including a slip form device to develop and demonstrate techniques and possible types of equipment to be used in the final design.

Jerry Fitzwater was the key person involved in the studies from the Hydraulics Branch. Jerry, with the help of several members of the Hydraulics Branch, performed most of the design on the features needed for the various aspects of the testing including the concepts, drawings, and operation of the hydraulic laboratory equipment.

Erosion Studies

The Applied Sciences Branch and Concrete and Structural Branch conducted the Concrete Erosion Studies. The Hydraulics Branch designed a removable placement form (figure 1) to house the samples in the permanent 4-ft-wide by 8-ft-high by 40-ft-long flume in the laboratory. Hydraulics Branch personnel operated the flume during testing to provide desired flow velocities and made velocity measurements during the testing to document the results. The concrete placement and turbidity measurements were conducted by the Concrete and Structural Branch and the Applied Sciences Branch.

Flow velocities tested were 0.5, 1.0, 2.0, and 3.5 feet per second. Results from these studies are given in a report "Impact on Water Quality from In-Place Lining of the Coachella Canal" by the Applied Sciences Branch.

Additional erosion tests were conducted in a portable sloping flume. In this configuration, samples in cylindrical containers were exposed to flow velocities of 1 and 2 ft/s. These tests were run for 4 hours each and the amount of erosion measured for various samples. Results are reported in "Mix Design Study for Placing a Concrete Canal Lining Underwater" by the Concrete and Structural Branch.

Mathematical Simulation

A two-dimensional fluid dynamics finite difference code was used to simulate flow around the form in a field situation. This study was done by Cassie Klumpp of the Hydraulics Branch to determine expected flow velocities which the fresh concrete would be exposed to. The flow contracts around the form exposing the fresh concrete immediately in back of the form to velocities as high as 4.90 ft/s. This problem could be resolved by covering the concrete in this area with a trailing protective cover of some kind.

Further Information on this study is given in a report "Underwater Canal Lining - Numerical Flow Studies" by Cassie Klumpp, Hydraulics Branch.

Demonstration Model

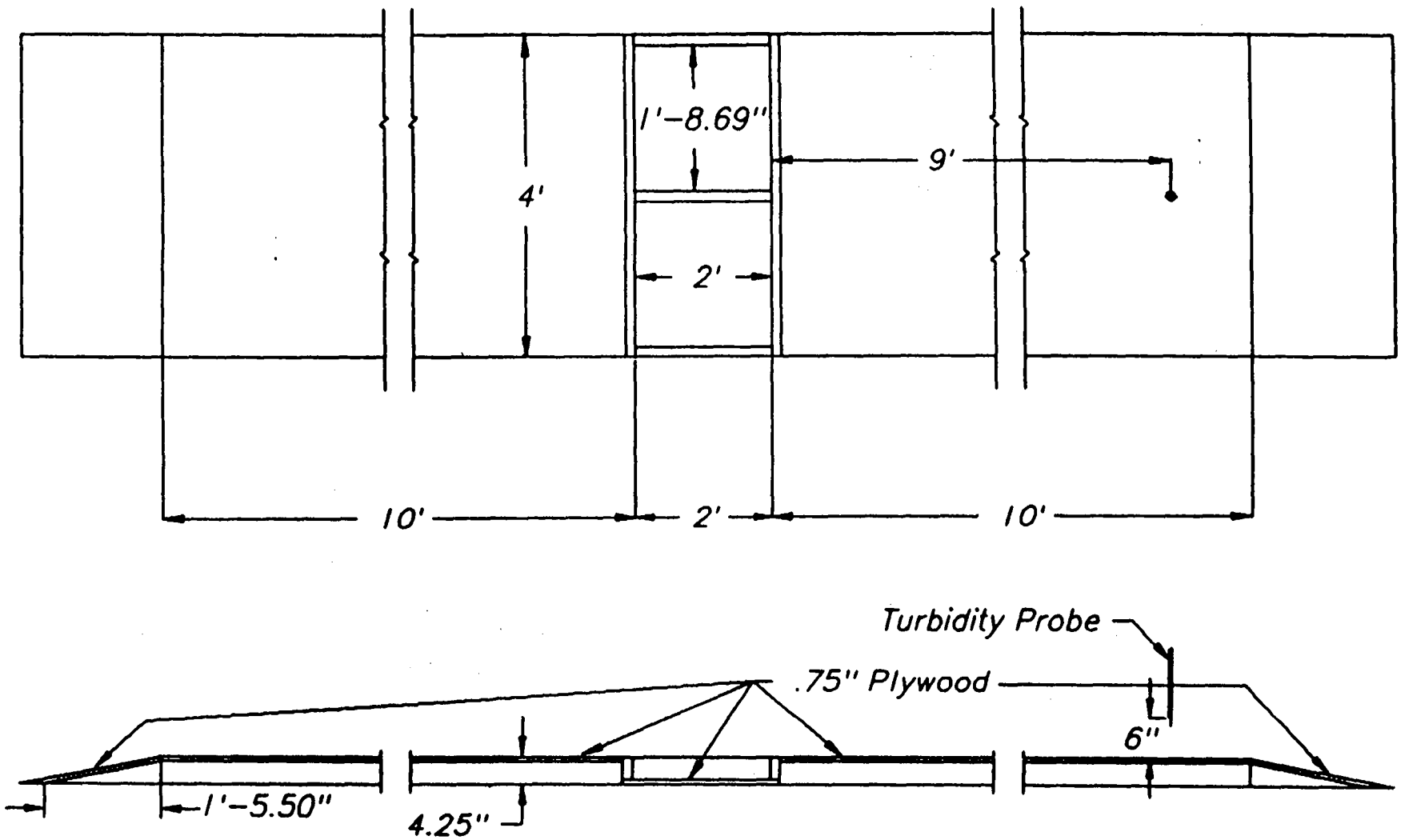
The majority of the research effort on this project went into the 1 to 3 demonstration model. The Hydraulics Branch designed the model (figure 2) and paving machine (figure 3), supervised construction of the model, and assisted in operation of the model during the actual placement tests. The paving machine (figure 4) was fabricated by a machine shop on a contract. The remainder of the model was built by the Laboratory Shops as designed by the Hydraulics Branch. The model simulated a 60-ft-long section of canal and included a 2-1/2:1 side slope and a short section of the canal bottom. The tests were conducted with the water level at a specified elevation. However, flow was not circulated through the model during the concrete placement tests, since the entire canal section was not simulated in the model and the flow patterns around the form would not be representative of the prototype conditions. The form was designed to follow tracks on each side of the model. Provisions were included to prevent the device from lifting off the tracks due to a tendency to lift which was noticed in earlier small scale tests. The machine advance rate was controlled by winches to advance and restrain the progress. Three tests were necessary to develop the techniques for placing the concrete. A fourth test was conducted to demonstrate the placement for prospective contractors preparing proposals for building equipment and placing a prototype 1-1/2 mile section at the Coachella Canal.

The demonstration tests were a joint effort involving all of the organizational units involved in the research. The coordination of efforts between groups was apparent in the successful development of a technique which demonstrated the viability of the concept to prospective bidders and provided data for specifications and determination of environmental impacts.

Enclosures

cc: D-3750, D-3700, D-3730, D-3740, D-3752, D-3752 (Fitzwater)
(w/encl to each)

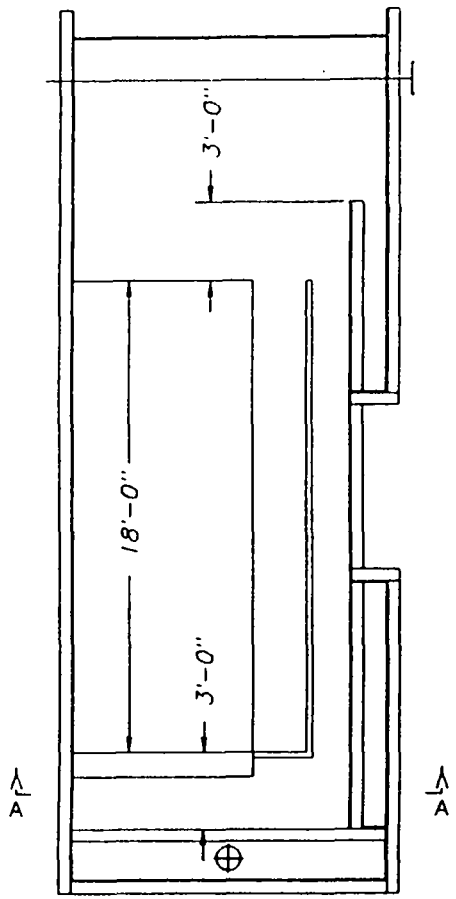
WBR:CAPugh:flh:4/20/89:236-6152
(wp\d3752\canal)



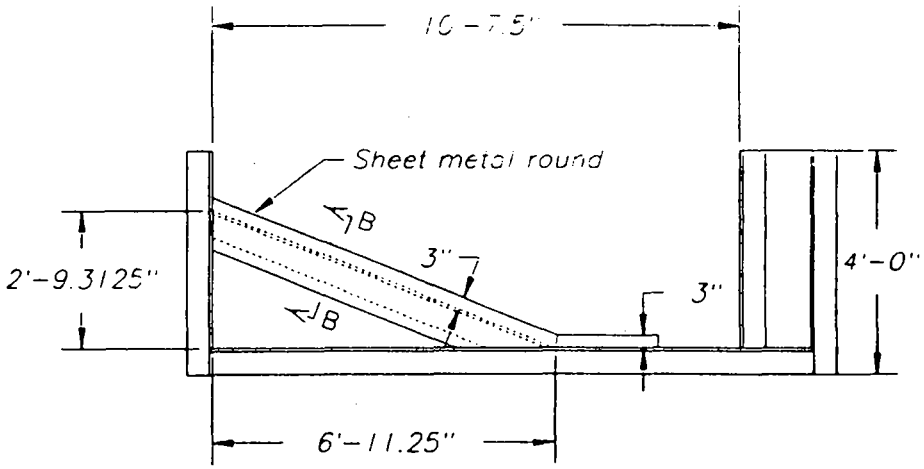
FRESH CONCRETE EROSION FLUME

FLOOR SECTION

FIGURE 1



PLAN



SECTION A–A

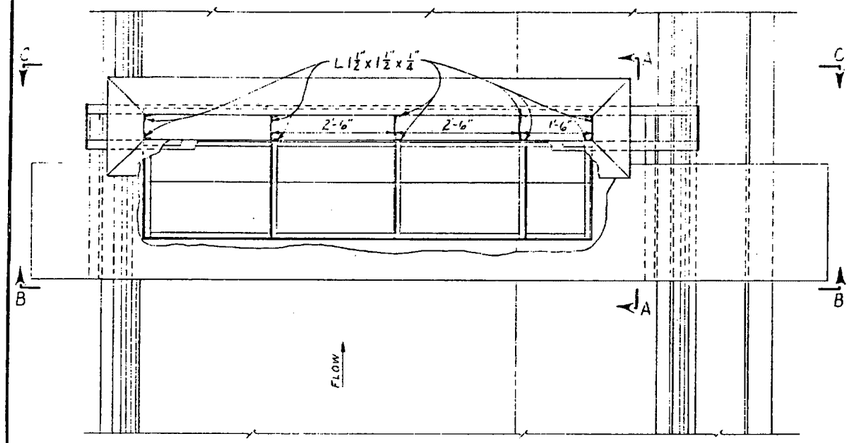
Figure 2

ALWAYS THINK SAFETY

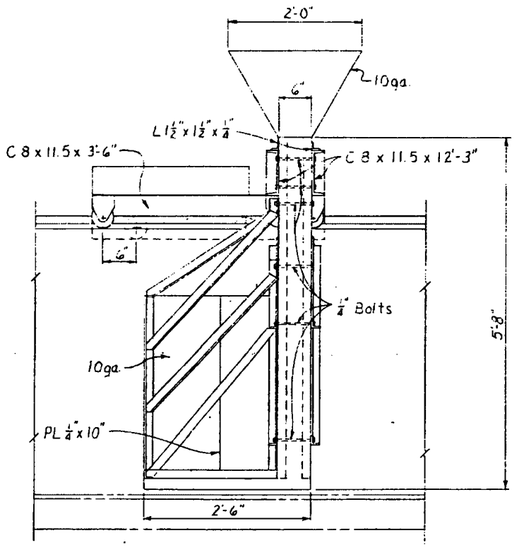
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CANAL LINING
MODEL

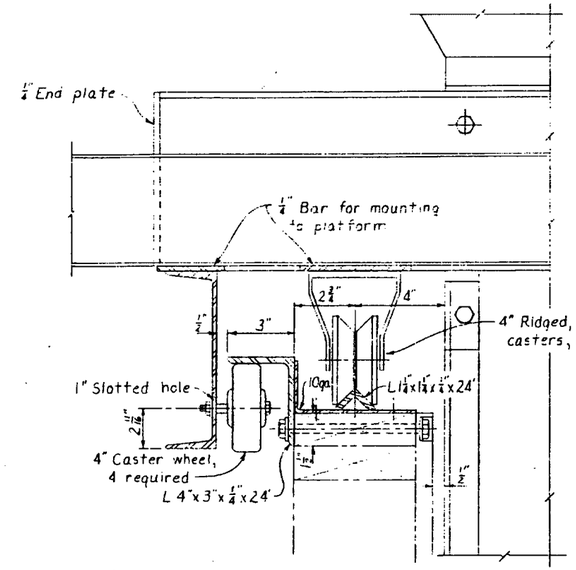
DESIGNED J. Schuster TECHNICAL APPROVAL
DRAWN J. Schuster SUBMITTED
CHECKED APPROVED
DENVER, COLORADO, FEB 5 1982



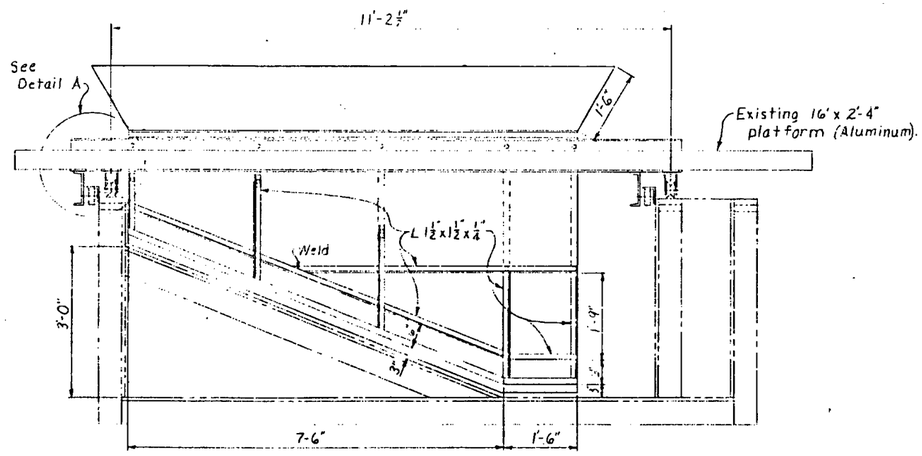
PLAN
¼"=1'



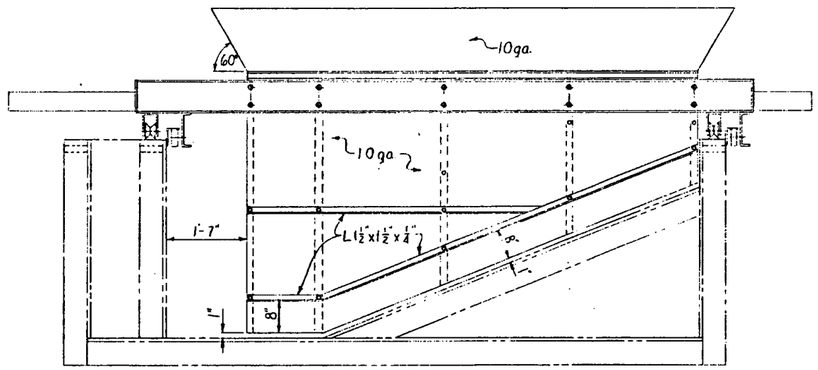
SECTION A-A
ROTATED 90°
1"=1'



DETAIL A
(TYPICAL)
4"=1'



SECTION B-B
¼"=1'



SECTION C-C
ROTATED 180°
¼"=1'

Figure 3

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR

CANAL LINING
SLIP FORM MODEL

DESIGNED _____ TECHNICAL APPROVAL _____
DRAWN _____ SUBMITTED _____
CHECKED _____ APPROVED _____
DENVER, COLORADO _____

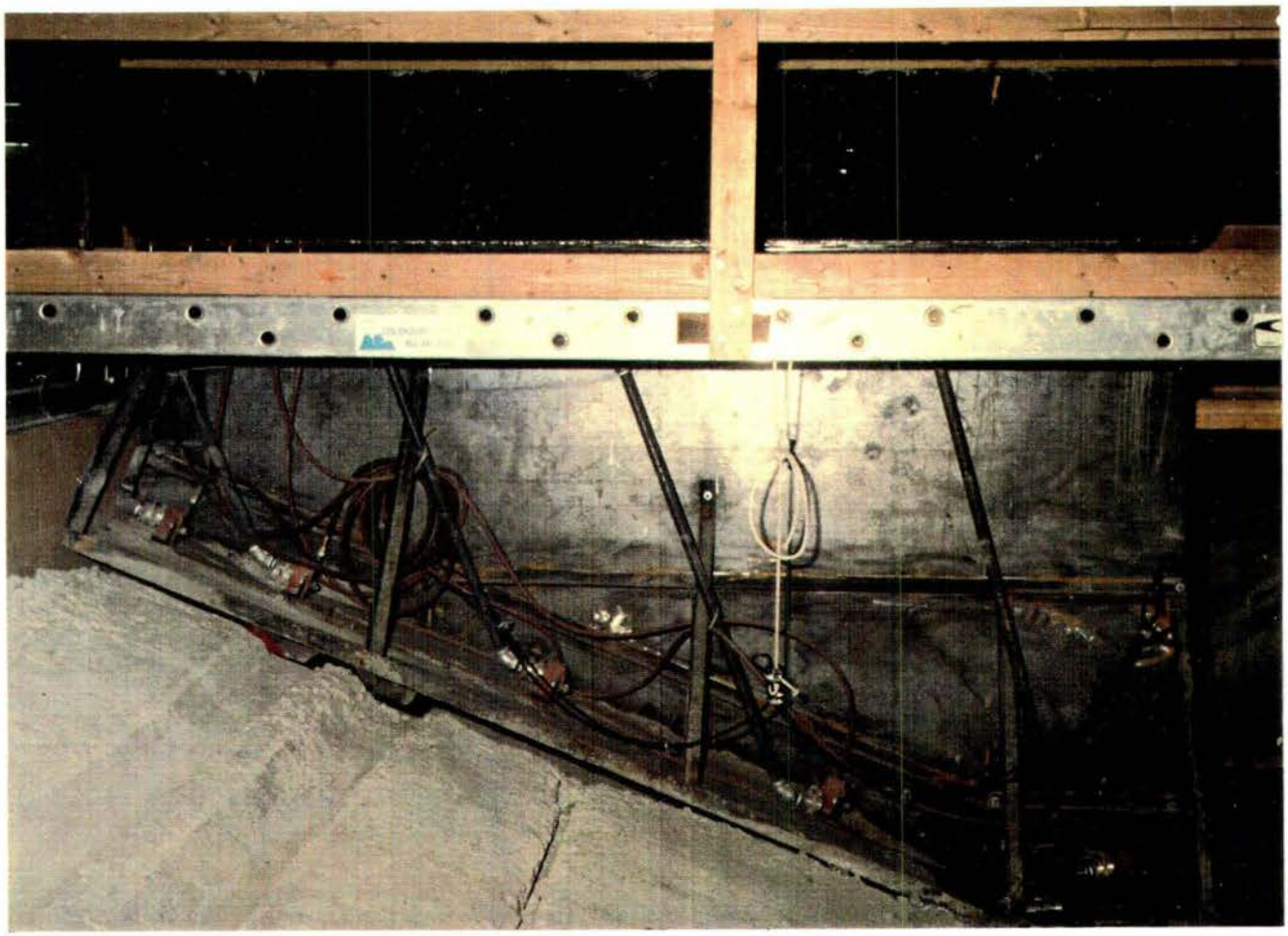


Figure 4. - Paving machine