UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

ABRASION AND PERCUSSION TESTS ON A VITREOUS-COATED GATE LEAF WITH CATHODIC PROTECTION

Hydraulic Laboratory Report No. HYD-349

ENGINEERING LABORATORIES BRANCH

DESIGN AND CONSTRUCTION DIVISION
DENVER, COLORADO

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Subject: Abrasion and percussion tests on a vitreous-coated gate leaf with cathodic protection

PURPOSE

Abrasion tests were conducted on a vitreous-coated turnout gate leaf to determine the wearing qualities of the vitreous coating when it is used with a standard extruded rubber guide and gate seal.

Following the abrasion tests, the gate leaf was subjected to a percussion test to investigate the bond between the vitreous coating and the metal.

CONCLUSIONS

The abrasion tests on the vitreous-coated gate leaf proved the coating to be satisfactory for normal use in irrigation systems. Using a head of 3 feet of water and assuming the average operation of a turnout gate involves opening and closing it 50 times per year, the amount of wear for the equivalent of 100 years of operation could not be measured with a micrometer.

The percussion test proved the bond between the vitreous coating and metal able to withstand shock more severe than would be encountered in normal use.

INTRODUCTION

Corrosive water found on many of the Bureau of Reclamation projects creates a major problem of maintenance on metal gate structures. In seeking a solution, arrangements were made with the A. O. Smith Corporation of Milwaukee, Wisconsin, to submit for tests two experimental turnout gate leafs covered with a vitreous protective coating and an attached cathodic protection device. One gate leaf was sent to this

office for testing in the laboratory, and the other leaf was sent to Yuma, Arizona, for testing under operating conditions in Colorado River water which contains elements that exhibit corrosive properties.

THE INVESTIGATION

The gate leaf supplied for test purposes was 30 by 31-1/2 by 1/8 inches in size as shown in Figure 1. The entire gate with the exception of the 1/8-inch edges of the leaf itself and the edges of the two 5/8-inch diameter holes located on the centerline of the leaf was covered with a vitreous protective coating. The vitreous protective coating was measured with a micrometer and found to be approximately 0.015 inches thick.

In field installations, the gate leaf moves within rubber guides of an extruded rubber seal. In the abrasion test set-up, Figure 2, it was expedient to reverse the procedure. The gate leaf was rigidly held in a box of water while the rubber seals were attached at opposite edges of a platform which moved back and forth over the leaf. Figure 3 shows the detail of the gate leaf and the rubber seal.

The rubber seals were 1.0 foot in length which, in effect, isolated a horizontal section on the gate leaf 1.0 foot high and the width of the gate leaf. Considering the bottom edge of the gate leaf to be under a 3.0 foot head of water, and the above section at its lower extremity, the platform was uniformly loaded by a force equivalent to that at the center of the section or 2.5 feet of water. See Figure 4.

A motor activated airplane landing gear retracting mechanism with an automatic reversal attachment was used to activate the loaded platform. The rubber seal traveled over the gate leaf at a rate of 0.6 inch per second. The length of travel of the seal was 3 inches which, considered with the 12-inch length of the seal, resulted in a total abraded surface of 15 inches. Of the total 15-inch surface, 9 inches in the center were in constant abrasion while the remaining 3 inches on each side alternated in the absorption of wear. A counter was attached to record the cycles of operation; that is, one cycle simulates one opening and one closing of the gate leaf in actual operation. The assumption was made that an irrigation turnout gate leaf is opened and closed an average of 50 times a year, or in the test set-up 50 cycles per year.

Four abrasion tests were conducted, the first performed in clear water with an operation period of 1,000 cycles representing 20

years of operation. There was no evidence of wear on the gate leaf surface, but the surface was marked, resembling a polishing effect.

The second abrasion test was a continuation of operation in clear water for 1,500 more cycles representing a total of 50 years of gate operation. The gate leaf under the seal was unchanged from that in the previous tests.

The third abrasion test consisted of 1,000 cycles representing 20 years of operation in silt-laden water on the same section of the gate leaf. Very fine sand was added to the water in the test box and was constantly agitated to keep the sand in constant contact with the surface receiving wear. Before the gate leaf was put into operation for this test, sand was actually placed between the gate seal and gate leaf, causing the worst possible abrasive condition. Wear on the gate leaf was still negligible.

The fourth abrasion test was a continuation of operation in the silt-laden water for 1,500 more cycles representing a total of 50 years of operation in clear water and 50 years of operation in the silt-laden water. A slight polishing effect is noticeable on the glossy finish of the gate leaf. A micrometer was used to determine the amount of wear resulting from the abrasion tests. The variation in thickness of the vitreous coating was as much or more than the variation due to wear.

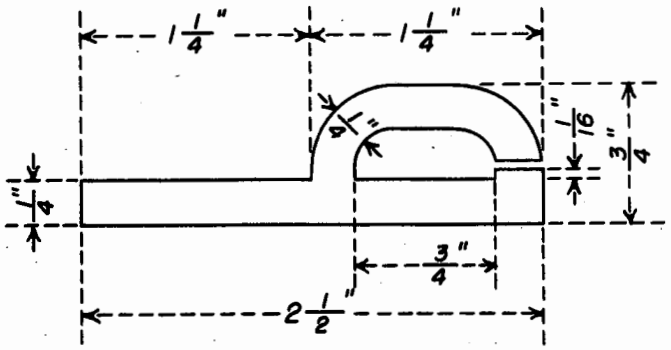
Photographs of the gate leaf were taken after each test. Because of lighting conditions they did not produce an image that corresponded to visual and physical observations, and therefore are omitted from this report.

Following the abrasion tests, a percussion test was performed to determine the bond between the vitreous coating and the metal. The gate leaf was placed flat on a table and hit with a hammer. A flat blow of the hammer did not affect the bond until the gate leaf was distorted. Angular blows of the hammer producing a chipping effect were found capable of breaking the bond.

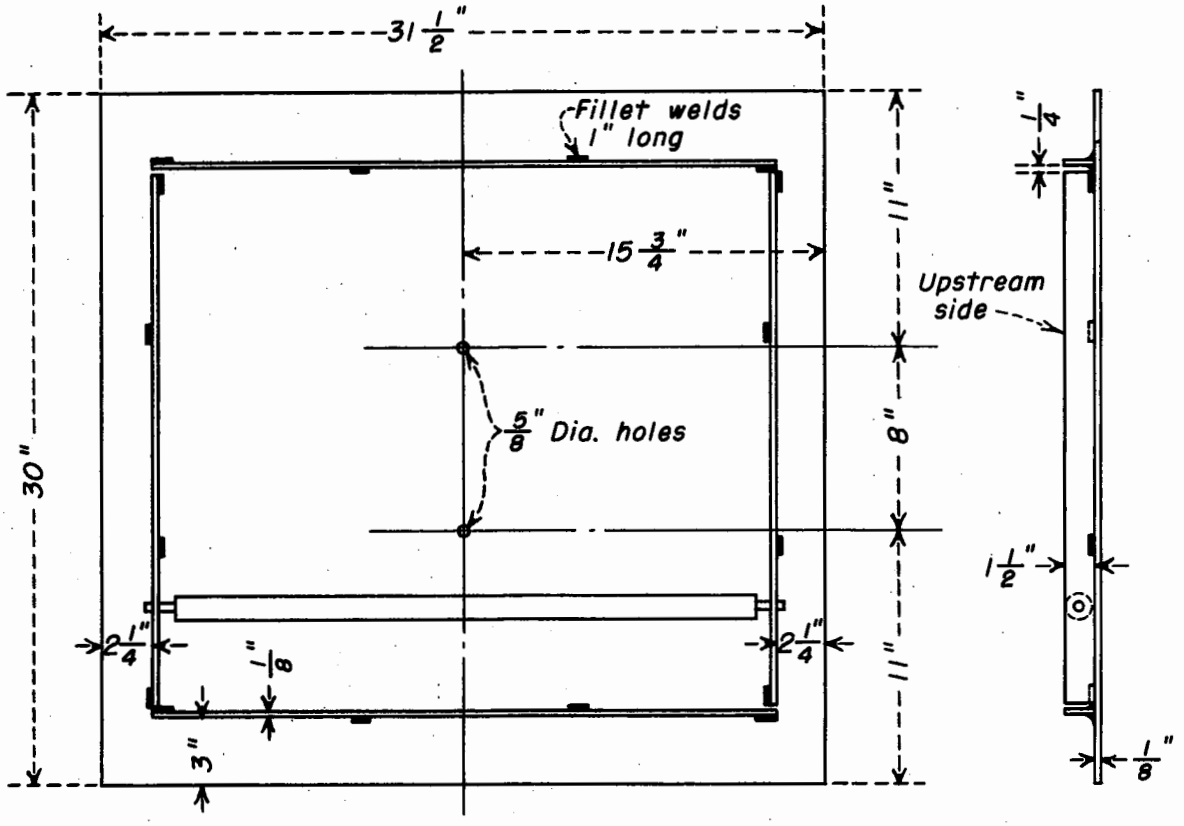
This report is concerned only with the abrasion and percussion tests. Further tests being made by the Chemical Laboratory are concerned with accelerated corrosion of the gate leaf and the action of the cathodic protection device. A report will be issued by that section, describing the test results. The results of any studies conducted by project personnel at Yuma, Arizona, will be disseminated upon receipt to appropriate individuals.

Interior - Reclamation - Denver, Colo.

FIGURE 1



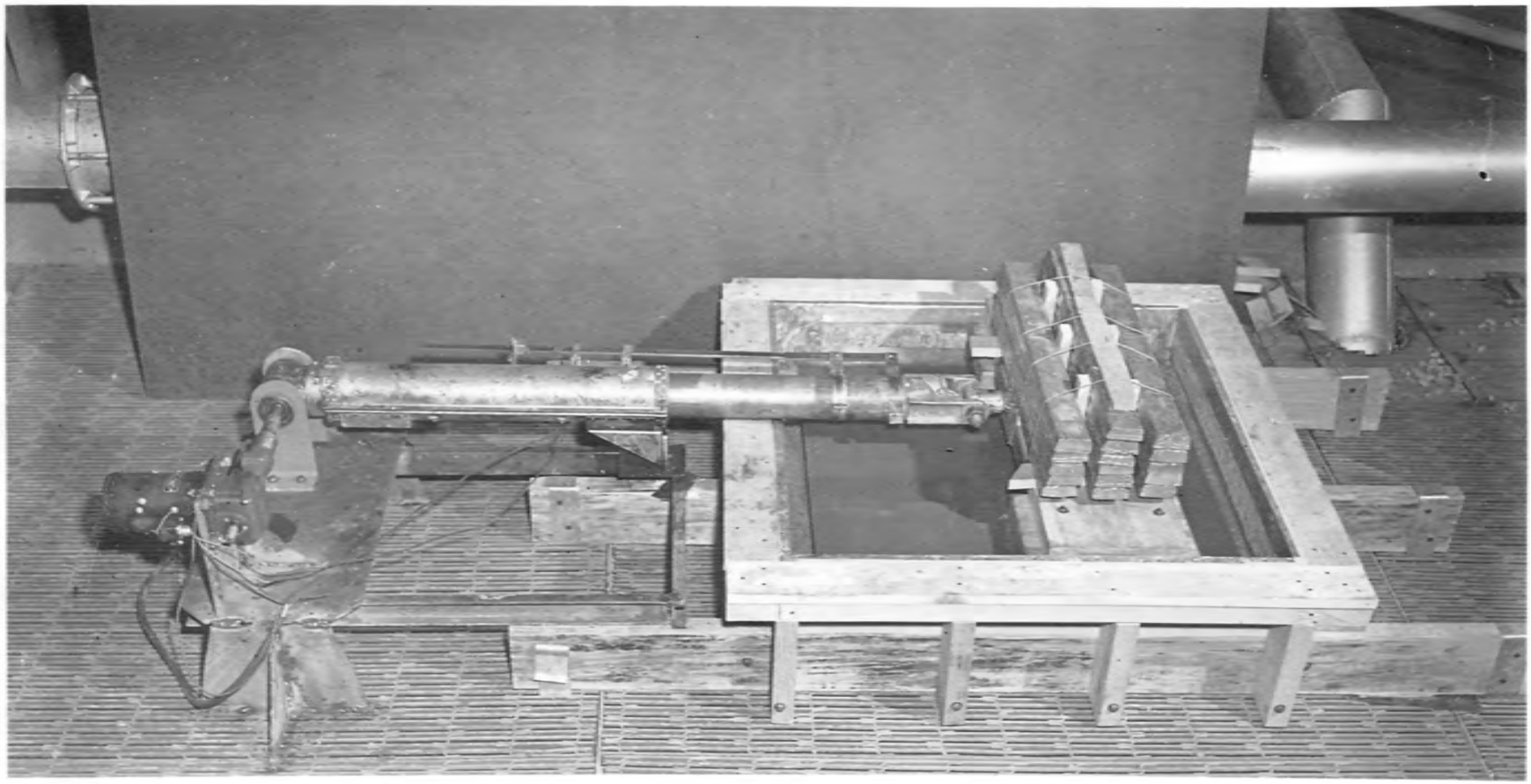
RUBBER GUIDE AND SEAL



GLASS COATED GATE LEAF

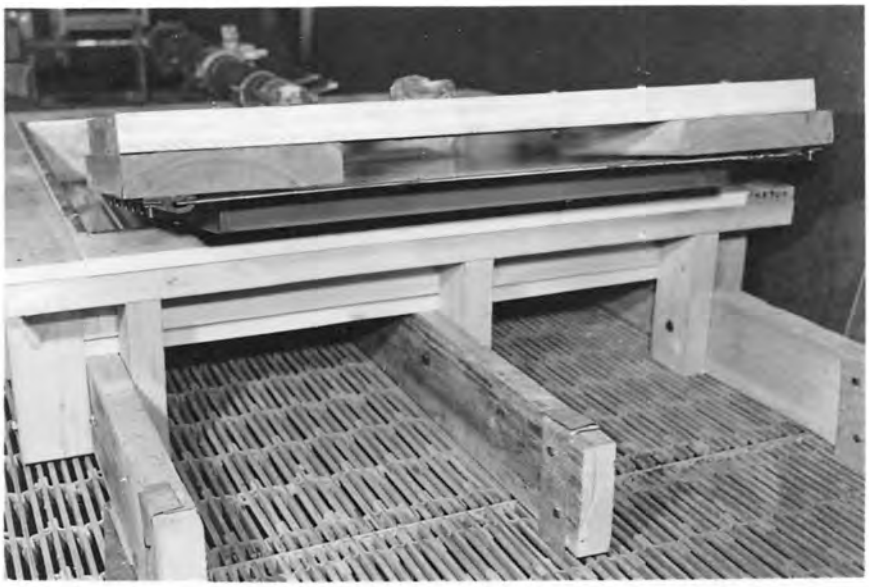
Note: All dimensions and notes taken from drawing by A.O. Smith Co.

DETAILS OF
VITREOUS COATED TURNOUT GATE LEAF

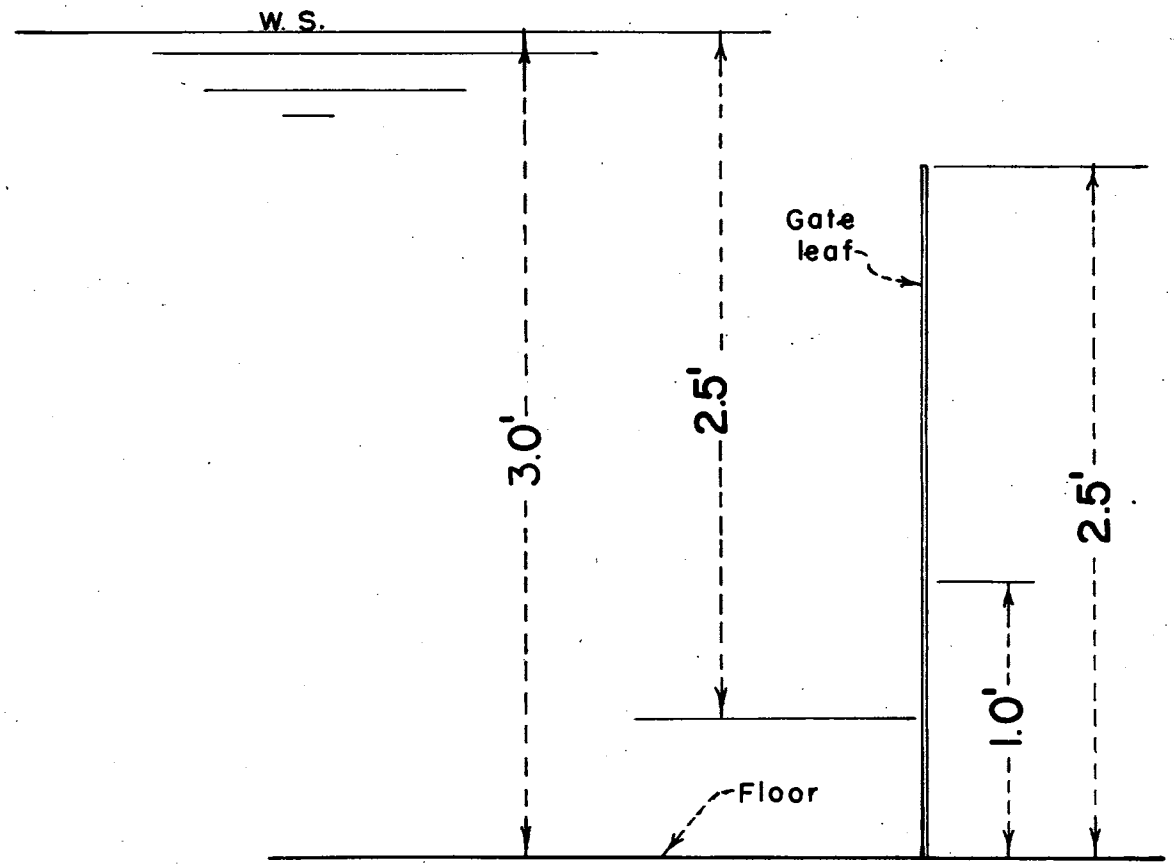


ABRASION TEST SETUP FOR THE VITREOUS COATED GATE LEAF

FIGURE 2



ABRASION TEST SETUP FOR THE VITREOUS COATED GATE LEAF
Closeup views of the gate leaf and the rubber seal



Force on lower 1.0' section of gate leaf

$F = WA\Delta H$

$F = 2.5 \times 2.5 \times 1 \times 62.45$

$F = 390^{\#}$

LOAD PLAN
VITREOUS COATED
TURNOUT GATE LEAF

FIGURE 4

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