A PRELIMINARY STUDY ON THE MAINTENANCE OF AN INCLINED SCREEN

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INTRODUCTION

Inclined screens fabricated of perforated plate or wire cloth screen have had widespread application in collecting juvenile migrants out of canals, small rivers, and streams. One of the most recent is now in use by the Bureau of Commercial Fisheries in a test facility on the Grande Ronde River near Troy, Oregon.

Notwithstanding the popularity of the inclined screen, little information was available as to how well suited such a facility might be for use as a fish screening device within a major river. There was considerable question as to just how the entire flow of a river could be passed through a screen without completely clogging the openings, or without developing a severe maintenance problem.

The purpose of this initial investigation was to explore the methods for cleaning debris from the screens in the search for the most efficient.

Studies on the effect of factors such as approach velocity, static head, screen angle, type and volume of debris and design of the plate screen upon screen efficiency are still in progress and will be reported later.

The flume was designed for a capacity of 80 cubic feet per second at a maximum velocity of 18 feet per second. Both water volume and velocity controls were built into the headwork of the flume. A series of stoplogs afforded head control, while a power-driven vertical steel gate placed several feet downstream from the stoplog section controlled flow volume.

DESCRIPTION AND OPERATION OF TEST STRUCTURE

To provide a structure in which various inclined screen tests could be conducted, a relatively small flume measuring 50 feet long, 4 feet deep, and 2 feet wide was constructed within a spillway section of the Stanfield Irrigation Canal, a diversion of the Umatilla River near Echo, Oregon.

The flume design (fig. 1) provided for the installation of four inclined screens, each measuring 2 feet by 4 feet, with a total length of 16 feet and a width of 2 feet. Slope of the total screen array could be varied in 5° increments from a minus 5° to a plus 5°.

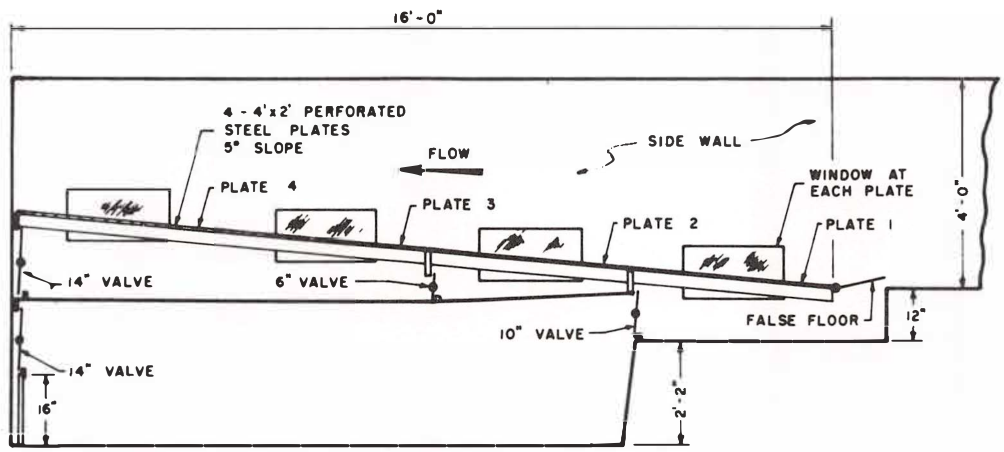

Figure 1.--Plan of the 1964 inclined screen experimental flume in the Stanfield Canal, Echo, Oregon.

Each test carried out in phases 1 and 2 used 12 gauge perforated plate screens (fig. 2) with 1/4-inch diameter holes staggered on 3/8-inch centers (40 percent effective open area) placed on a 5^{o} slope. To allow for observation of the plates and flow through the plates, plexiglass windows--one for each plate screen--were installed along one side of the flume.

To control the static-pressure head passing through the openings of the screens, individually gated compartments were constructed directly under plates 1 and 2. Also, a single-gated compartment combining plates 3 and 4 was fitted directly between these two plates. A false door was installed several inches upstream from plate 1 (fig. 1).

Accurate water depth readings could be taken through the use of piezometers installed at specific points throughout the length of the flume.

TECHNIQUES TESTED

False Floor

The first technique used to clear the plate screens of debris involved the use of the false floor (fig. 1), which when opened for a brief period, allowed a portion of the high velocity approach flow (12 f.p.s.) to pass into the gated compartment under plate 1 and up through the plate perforations in a reverse direction.

Water Hammer

The second technique to clean the screens utilized the operating principle of the water hammer. When the relatively high velocity of flow passing through the perforations of the plate and into a compartment was interrupted by rapid closure of the compartment valve (fig. 1), the onward motion of the water was suddenly halted. As a result, inertia of the flow caused a sudden high pressure, the effect of which was like a hammer blow which set up a pressure wave moving at a high velocity in a reverse direction through the perforated plate screens. It was this reversal of flow which cleaned the screens.

Vibrators

A third technique was developed in which air-actuated vibrators were attached to the underside of plates 3 and 4 (fig.3). These devices vibrated 16,300 times per minute at 90 pounds per square inch.

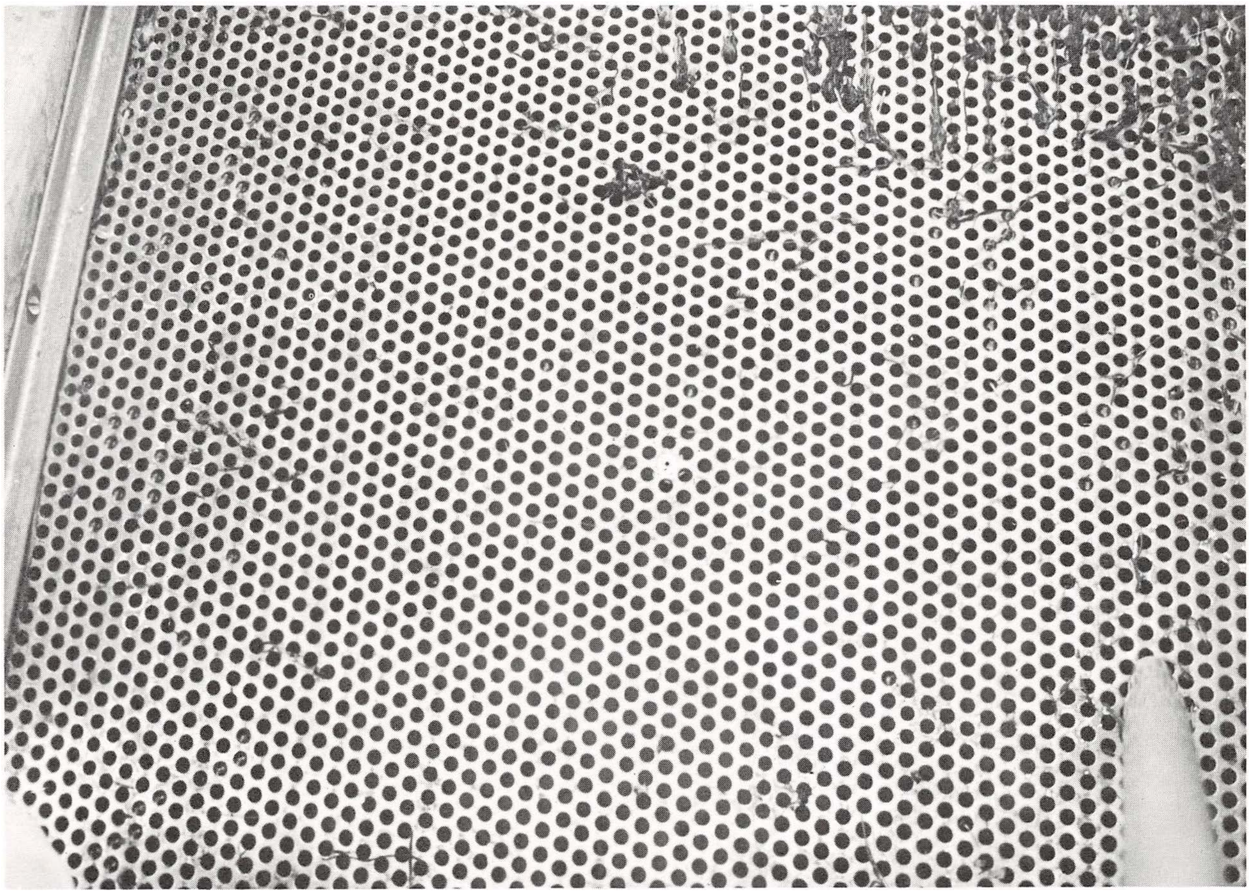

Figure 2.--Perforated plate screen with 1/4-inch diameter holes staggered on 3/8-inch centers, providing an effective open area of 40 percent.

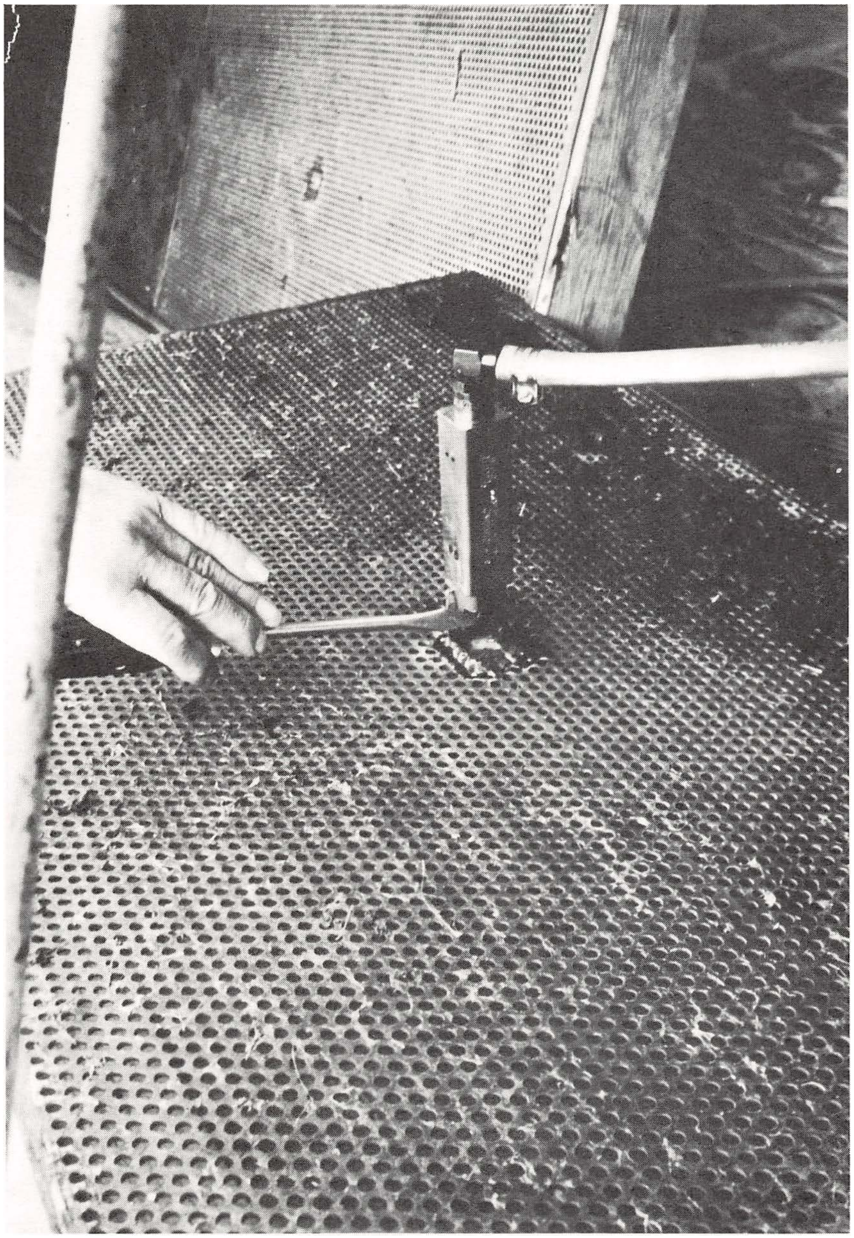

Figure 3.--Air-actuated vibrator attached to the underside of a perforated plate screen.

Water Jets

A fourth method evaluated was the use of high velocity water jets. Two different systems were used in this test. The first involved the use of water jets directed upward from the underside of the perforated plate screens (fig. 4). The jets discharged about 3/4 of an inch from the bottom of the plate screens. The entire jet assembly traveled along a track parallel to the direction of flow and beneath plates 3 and 4. A water pressure of 50 pounds per square inch through the jets was used.

The second water jet system was designed to eliminate the travel required in the first method. In this study a 6-inch diameter pipe was positioned directly underneath the plates and extended along a midline their full length. It could be readily turned to cause the 3-inch spaced spray jets to rotate in an arc of 180 degrees, sufficient to clean the entire screen width (fig. 5).

RESULTS AND DISCUSSION

Use of the false floor cleaning technique resulted in a thorough cleaning of a 12-hour accumulation of debris in approximately 1 second. The rush of water from below provided by the opened floor section instantly lifted debris free of the plate where it was swept away by the high velocity flow passing over the screen. One exception to this was when the debris included a large proportion of filamentous algae.

Results of the water hammer operation were equally favorable. It was found that debris could be instantly cleared, again with the exception of filamentous algae, from the plates within less than 1 second. It was also true with this cleaning technique--as with the false floor--that unless the screens were cleaned every 5 hours (approximately) or less, the instantaneous cleaning action was lost and that more time was required to accomplish the task. With the addition of vibrators to plates 3 and 4 there was a marked reduction in the extent of clogging when compared to similar tests conducted on the same day and for the same period of time without vibrators.

Both water jet systems thoroughly and rapidly cleaned the entire screen array, including algae. Because of the ease of operation there was considerable advantage in use of the rotating pipe system. The results of those tests dealing with various screen cleaning methods, with specific reference to use of the false floor as well as to the water hammer principle, were

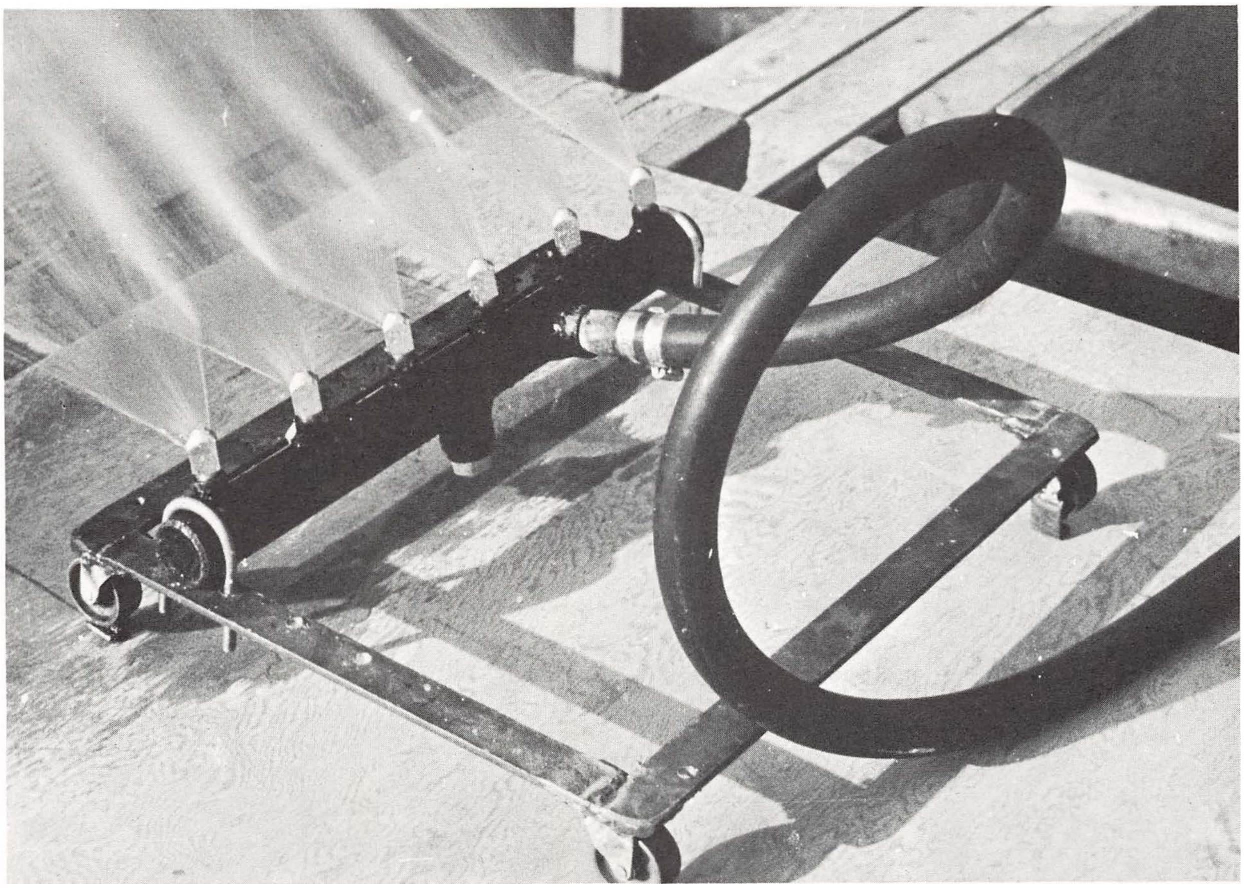

Figure 4.--Traveling water jet system used in cleaning perforated plate screens.

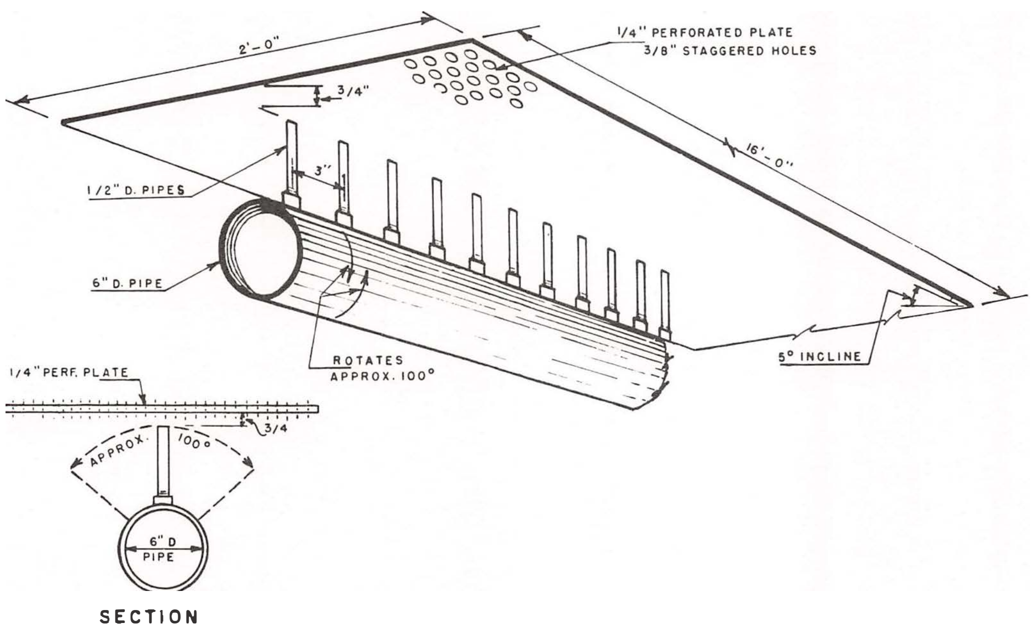

Figure 5.--A portion of the water jet pipe showing its position relative to the perforated plate screens.

satisfactory. However, it was indicated that the longer the time interval between screen cleaning periods, the more time in terms of seconds was required to accomplish cleaning. It should be noted that in the use of the water hammer principle, should the screens clog to the point of allowing little or no flow to pass through, the use of the principle is lost.

Irrespective of the cleaning system adopted, there is always the possibility of a severe debris load passing onto, and rapidly and completely clogging a screen. The immediate result would be the total engulfment of the structure by the river flow.

SUMMARY

The possible application of the inclined screen for use in deflecting juvenile salmonids from rivers, streams, and canals was examined from the standpoint of how the screens could best be cleaned. Although several systems were developed which cleaned the perforated plate screens successfully, the high pressure wash system appeared to be most promising from the standpoint of application.

Results of tests on inter-relationship of such factors as head, velocity, screen design, and type & volume of debris have not been concluded at this time.