VALUES - MARFIOU-ALPACA

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Denver, Colorado

January 19, 1949

Memorandum

To: H. G. Curtis

From: C. W. Thomas
Through J. E. Warnock

Subject: Hydraulic test of a 10-inch Martin Alfalfa Valve manufactured by Martin Iron Works, Los Angeles, California.

1. The Contra Costa Distribution System may require control valves that will operate under heads of approximately 125 feet of water. For this reason a 10-inch Martin, Type B, Alfalfa Valve was secured from the Martin Iron Works for the purpose of testing at a high head.

2. This Martin Alfalfa Valve fits over the end of the pipe as a cap, Figure 1. It is a painted casting and is grouted onto the plain end of a concrete pipe after the pipe has been chipped to allow for the valve cross member. The valve diameter is approximately 3/4 inch larger than outside diameter of the pipe so that a space approximately 3/8-inch wide and the depth of the valve body, about 1-1/2 inches, is left around the pipe to be filled with portland cement mortar. The sides of the valve body are parallel to the sides of the pipe, which would indicate that adhesion of the painted casting to the mortar is the only force to hold the valve onto the pipe. The mortar applied consisted of one part of cement to two parts sand. A sieve analysis of the sand showed 17.5 percent retained on the No. 16 sieve; 23.5 percent on the No. 30 sieve; 29.5 percent on the No. 50 sieve; 23.5 percent on the No. 100 sieve; and 6 percent passing the No. 100 sieve. The mortar was supported around the end of the pipe and the valve was pressed down firmly forcing the mortar into the valve body. Excess mortar was removed. The pipe was left standing in a vertical position and the valve and upper part of pipe were covered with wet sand to cure the mortar, Figure 2. The curing period was 28 days with the sand being wetted down frequently enough to prevent drying.

3. After 28 days of curing, the section of concrete pipe with valve secured was connected in a vertical position to a water supply. Water was run through the valve to clear the line of all air and to observe flow conditions before closing the valve completely. With the valve closed the head was built up slowly by means of two 100-foot head pumps in series, and controlled by means of a bypass. The hemp packing on the valve seat leaked considerably at a head of 50 feet and failed at a head of approximately 60 feet. The head was further increased slowly

to 80 feet. Without noticeable adjustment the head surged slightly in excess of 100 feet and the vertical concrete pipe failed.

4. The valve and pipe were inspected after the test and it was found that the valve seat packing had failed where the two ends of the hemp rope meet, Figure 3. Also the valve had started to creep off the end of the pipe and had moved approximately 1/16 inch, lower portion of Figure 3. The pipe had broken on a diagonal, midway between the top and bottom of the pipe, Figure 4.

5. Conclusions. The brief tests lead to the following conclusions:

a. The necessity for chipping the pipe for the cross member during installation is objectionable in that additional labor is required.

b. Any alfalfa-type valve causes the issuing jet to be directed upward at an angle. Under heads sufficient to cause the jet to break through the backwater, the height of the surrounding structure must be increased to retain this jet. For use on high heads, the needed height of surrounding structure would probably be excessive.

c. The hemp packing on the valve seat is not adequate for heads above approximately 25 feet of water and will fail completely at approximately 50 feet.

d. The method of securing the valve to the concrete pipe is not satisfactory for the 50- to 100-foot heads and possibly under lower heads because the effectiveness of the grout joint secured in the laboratory was very probably greater than that possible to obtain in the field.

CWT

CC-J.E.Warnock
Hydraulic Laboratory Files (2)

FIGURE 1

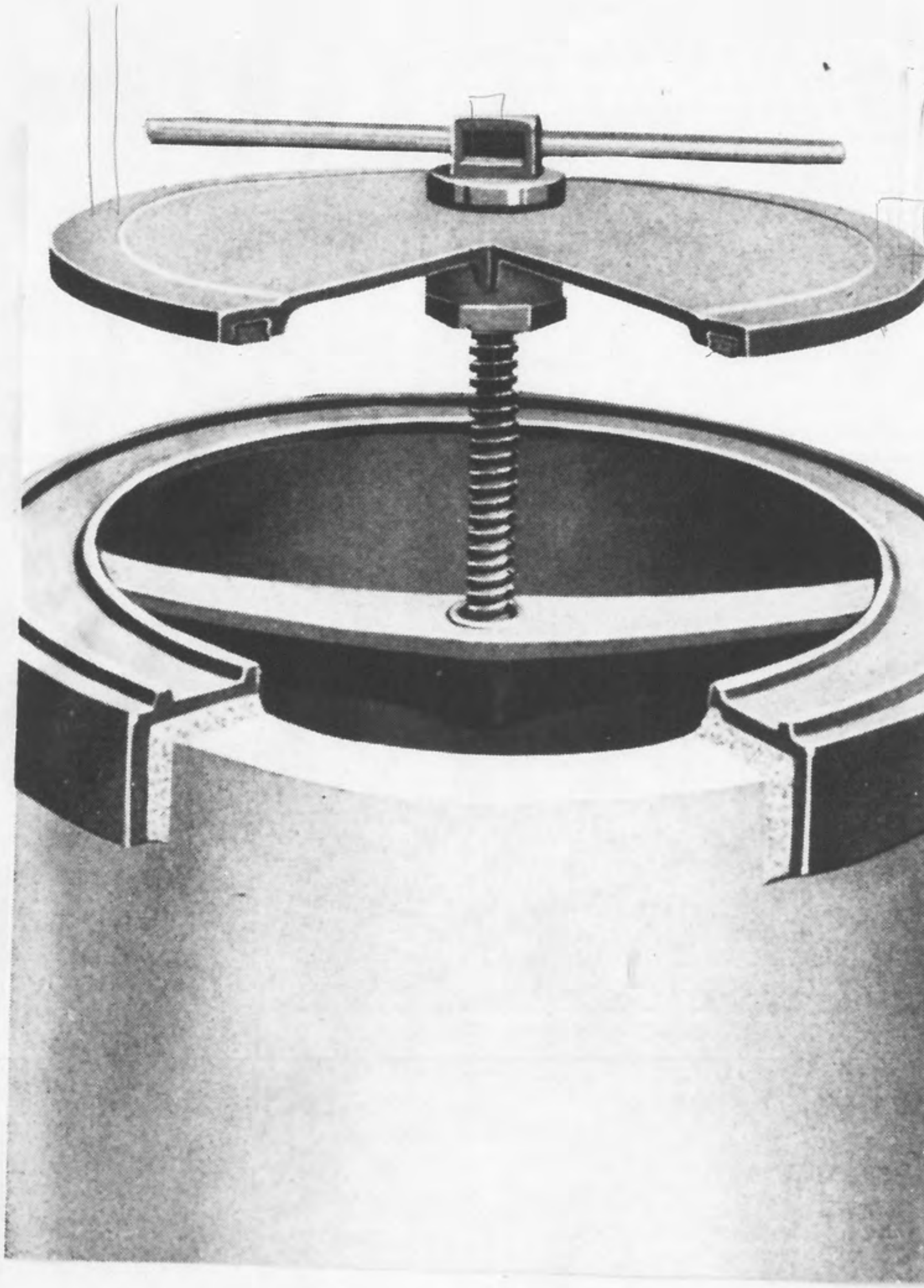
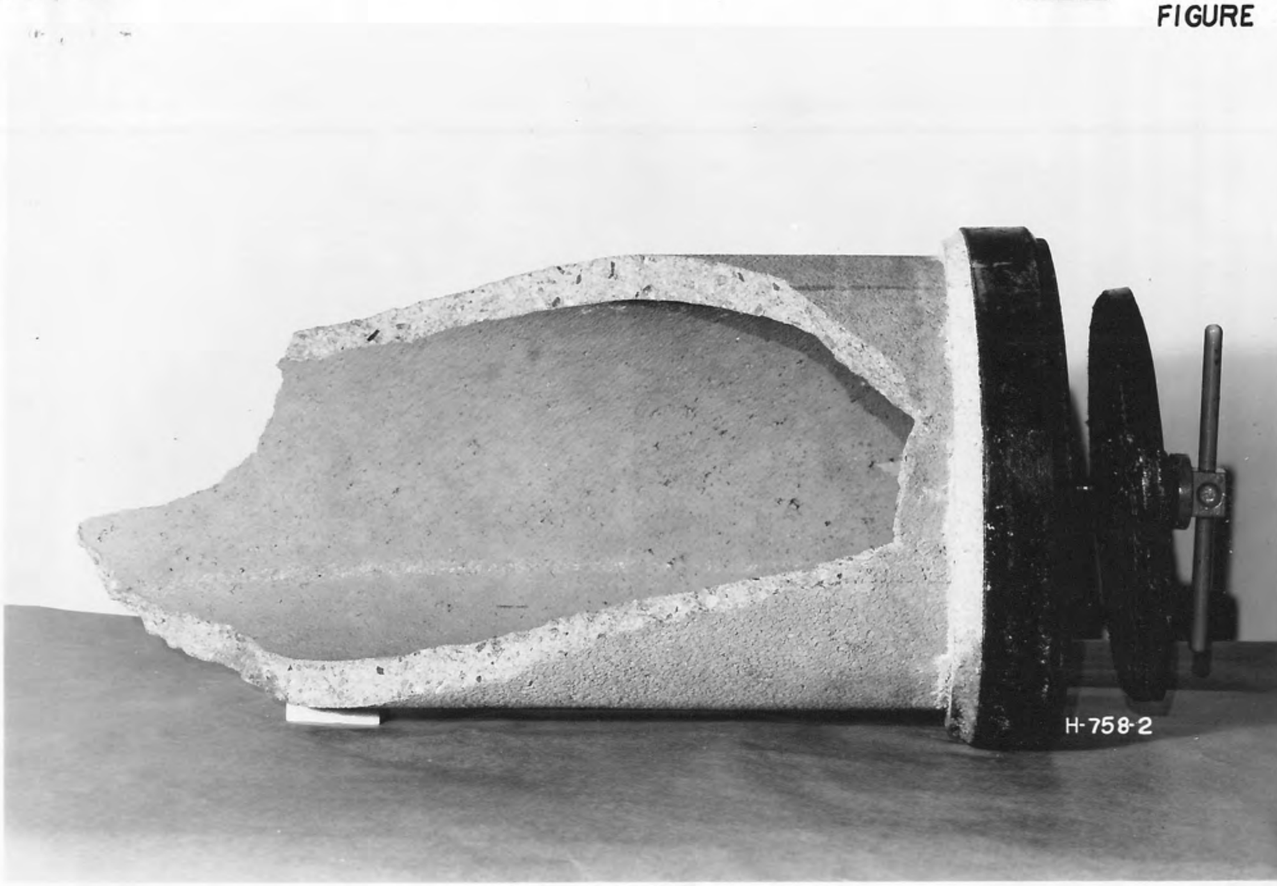


FIGURE 2

FIGURE 3

FIGURE 4



Studies of Pressure-Head Losses in Concrete Risers and Alfalfa Valves

By Verne H. Scott

TESTS have been carried out recently in the hydraulics laboratory of the division of irrigation, University of California, Davis, to determine the head loss occurring in water passing through concrete risers and alfalfa valves. In some cases these losses are considerable and should be taken into account in the design of pipe line systems.

An engineer designing a concrete irrigation pipe system must consider several factors before he can determine the best arrangement for successful operation. Design problems usually fall into two classifications: determining the proper pipe line sizes, or determining the required height of stands, stacks, or division boxes needed to carry the flow of water in the pipe line. In either case, factors considered by the engineer are (1) the flow required at division points or outlets, (2) the head available or required in each length of pipe, which depends largely on the slope and lay of the land as determined by a topographic survey and (3) the amount of friction between the flowing water and the walls of the pipe. Another factor often overlooked or simply estimated is the head loss that occurs in a pipe line due to risers with outlet valves installed on the line. The following discussion describes the laboratory setup used and gives the data obtained from the study of losses occurring in risers.

In order to test the hydraulic properties of the riser, a 14-in dry-mix concrete supply pipe was laid on a sump floor in the laboratory, and a riser attached. The riser being tested was cemented to the top center of the 11th section, 31.5 ft from the entrance end of the supply pipe. A hole was carefully cut in the supply pipe of the same size as the inside diameter of the riser. The riser which extended 30 in above the top of the supply pipe, was shaped to fit snugly over the hole. The transition area on the inside between the pipe line and the riser was worked smooth by hand with neat cement. A metal-lined ponding basin in which water could be controlled to regulate submerged conditions was built around the riser.

Water was pumped through the laboratory water distribution system to the entrance of the supply pipe. Measurements on a calibrated 8-in flow nozzle or a 12-in orifice plate determined the rate of flow. At various locations on the supply pipe, and at the top and bottom of the riser, manometer connections (Fig. 1) of ¼-in copper tubing transmitted the local pressure via rubber tubing to glass tubing mounted on a board on the side of the ponding basin. This made it possible to record rapidly differentials in pressure head at all points in the system.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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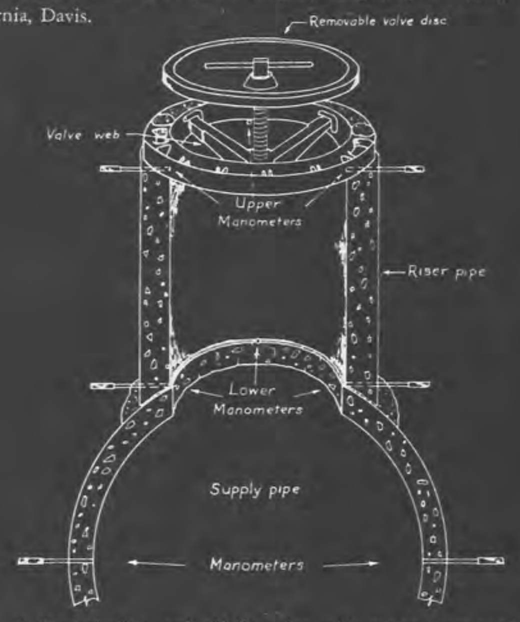

Fig. 1 Typical riser and alfalfa valve with manometers used in the study of pressure-head losses

Test Procedure. Eight, 10, and 12-in risers, the sizes most commonly used in irrigation practice, were tested. For each size of riser a series of six tests were conducted to determine the head loss for various rates of flow with riser conditions as follows:

Test 1 Riser unobstructed (without valve web).

Test 2 Riser unobstructed and valve seat submerged to various depths.

Test 3 Riser with web inserted in valve seat.

Test 4 Riser with web inserted in valve seat and valve seat submerged to various depths.

Test 5 Riser with web inserted in valve seat and the valve disk adjusted to various openings, i.e., the area between the bottom face of the valve disk and the top of the valve was varied.

Test 6 Riser with web inserted in valve seat and the depth of submergence changed for a range of valve openings.

Determinations of the pressure-head loss were made in each test for various rates of flow. Measurements of the loss were obtained from the manometer readings. This loss was equal to the difference between the average pressure head in th supply pipe before entering the riser and the average pressure head at the outlet of the riser (Fig. 1, upper manometers). In tests 1 and 3 the only variable condition was the rate of flow. In tests 2 and 4, for each rate of flow the depth of submergence was increased in 1.4-in increments. In test 5 the valve opening was varied in ½-in vertical increments. In test 6 the valve openings were identical to those in test 5, but the valve was submerged to various depths.

Discussion of Results. Head loss was plotted against rate of flow in each test for the three sizes of valves. Fig. 2 presents the results of these tests. The equations of the curves representing the points in this figure were calculated and are as follows; (in these equations, h = head loss in inches, and Q = rate of flow in cubic feet per second):

Test	8-in riser	10-in riser	12-in riser
1	$h=2.16Q^{2.11}$	$h=0.76\ Q^{2.22}$	$h=0.349Q^{2.29}$
2	$h=2.07Q^{1.95}$	$h=0.69\ Q^{2.39}$	$h=0.293Q^{2.52}$
3	$h=2.61Q^{1.97}$	$h=0.896Q^{2.19}$	$h=0.416Q^{2.30}$
4	$h=2.54Q^{2.20}$	$h=0.854Q^{2.23}$	$h=0.384Q^{2.33}$
5	$h=2.79Q^{2.12}$	$h=0.974Q^{2.05}$	$h=0.416Q^{2.61}$
6	$h=2.76Q^{1.98}$	$h=1.022Q^{2.05}$	$h=0.472Q^{2.13}$

A comparison of head-loss values (Table 1) between tests 1 and 3 for all three sizes of valves shows an increase in loss by inserting the web in the valve seat. At 0.5 cfs this increase amounted to 0.16 in for the 8-in riser, 0.04 for the 10-in riser, and 0.01 for the 12-in riser, however, at 2.0 cfs this increase amounted to 0.9 in, 0.55 in, and 0.35 in, respectively.

An attempt was made to reduce this web-loss effect by designing a more streamlined web. Such a web was made and tested on the 8-in valve. A small reduction in loss was noted. A comparison between values for the riser without the web and with the web showed that the head loss for flows of 0.5, and 1.0, 1.5 and 2.0 cfs was increased by 0.17, 0.45, 0.75 and 0.80 in respectively, by insertion of the web. For the same flows the increase in loss attributed to the streamlined web was 0.05, 0.25, 0.45, and 0.70 in.

The data indicate that submergence may be beneficial in reducing head loss to some extent (Table 1, comparison of values from tests 2 and 4 with 1 and 3 for each riser). Exceptions to this were noted at low flows. The magnitude of the reduction was not great, and when this effect did occur, it was apparent as soon as the outlet of the valve was submerged. When the values of head loss for a steady flow were plotted against depth of submergence, no change was noted in the loss for additional depths beyond initial submergence.

Table 1. Comparison of Pressure-Head Loss for Quantities of Flow in 8, 10, and 12-in Alfalfa Valves and Risers

	Quantity of flow, cfs			
Test	0.5	1.0	1.5	2.0
		8-in (Head loss, in)		
1	0.50	2.26	5.08	9.30
2	0.53	2.03	4.55	8.00
3	0.66	2.60	5.80	10.20
4	0.56	2.55	6.20	11.15
5	0.64	2.77	6.60	12.00
6	0.69	2.75	6.18	10.80
		10-in		
1	0.16	0.75	1.86	3.55
2	0.13	0.69	1.85	3.62
3	0.20	0.89	2.20	4.10
4	0.18	0.84	2.10	4.00
5	0.23	0.98	2.25	4.05
6	0.25	1.01	2.33	4.20
		12-in		
1	0.07	0.35	0.88	1.70
2	0.05	0.30	0.82	1.68
3	0.08	0.42	1.05	2.05
4	0.07	0.38	0.99	1.94
5	0.08	0.47	1.15	2.25
6	0.11	0.47	1.12	2.07

In test 5 where the valve opening was changed, and in test 6 where the depth of submergence was altered for various valve openings, no significant change could be detected in the head loss as these changes were made. Consequently, the head loss for any flow in test 5 represented an average of the differences between pressure-head conditions in the pipe line and at the top of the riser for a range of valve openings, and in test 6 for a range of valve openings and varying depths of submergence.

The restriction of the valve opening by closing down the valve disk resulted in slight increases in the amount of head loss. Comparison of values between tests 3 and 5, and 4 and 6 (Table 1) for the three sizes of valves tested shows that for practically every discharge some increase in head loss occurred when the valve disk restricted the opening. The values ranged from 0.01 to 2.20 in.

Since a sudden loss of pressure head occurred in the transition from the pipe line to the riser, computations were made to determine what per cent of the observed pressure-head loss could be accounted for by the calculated theoretical velocity-head differential, the difference between the velocity head in the supply pipe and velocity head in the riser. Results from all the tests show that the theoretical velocity head is from 40 to 80 per cent of the recorded drop in pressure. It is probable that the remaining percentage is accounted for by turbulence and friction loss at the entrance to the riser.

CONCLUSIONS

It is apparent from these data that the pressure-head loss for discharge rates within the usual range of irrigation practice for the sizes of risers and valves tested is not large. For an 8-in riser and valve the loss that could be expected for discharges of 0.6 to 0.9 cfs would be 0.07 to 2.8 in; for the 10-in with 1.3 to 1.7 cfs, a loss of 1.1 to 3.0 in; and for the 12-in with 2.0 to 2.5 cfs, a loss of 2.0 to 3.2 in. However, if larger quantities of water are required, losses may become an important factor. It should be pointed out that the loss for various rates of flow in these tests probably represents a minimum value since the test apparatus was installed with greate care than that exercised by commercial pipe layers. Therefore it may be reasonable to make an additional allowance fo field installations.

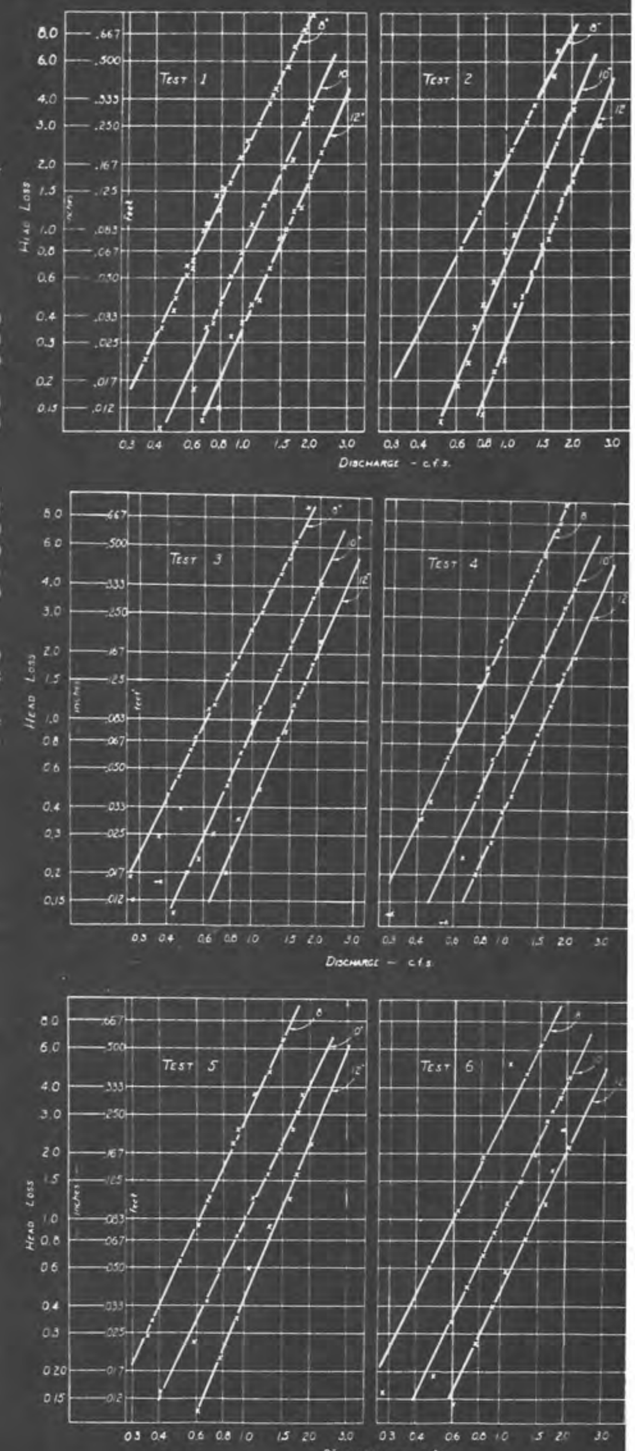

Fig. 2 Relationship between head loss and discharge in 8, 10, and 1 in concrete risers and alfalfa valves under the following condition: Test 1, riser unobstructed (without valve web); test 2, riser unobstruc ed and valve seat submerged to various depths; test 3, riser with we inserted in valve seat; test 4, riser with web inserted in valve seat an valve seat submerged to various depths; test 5, riser with web inserte in valve seat and valve disk adjusted to various openings; test 6, ris with web inserted in valve seat and the depths of submergence change for a range of valve openings