

# COMPARISON OF THREE COMMERCIAL *in a heavy clay soil of Imperial*

F. E. ROBINSON • J. N. LUTHIN

No evidence was found in these tests of real differences in performance between clay, concrete, or bituminous-fiber tiles. Differences in tile outflow were due primarily to soil variation and not to tile performance. Little actual change in salinity resulted from the leaching operation in the body of soil between the tiles. In most cases as much, and often more, water was lost through seepage as was removed by the tile. Much of the water which moved through the soil followed the disturbed trench above the tile, as evidenced by the much lower salinity in that trench. Electrical conductivity of the tile effluent was inversely related to both rate and duration of tile flow. Each tile showed a unique relationship between electrical conductivity, rate, and duration of flow—probably a reflection of a unique combination of hydraulic conductivities along each tile line.

**I**N JANUARY 1964, pairs of clay, concrete, and bituminous-fiber tiles were installed in a 40-acre field at the Imperial Valley Field Station. The tiles were laid at 6-ft depths, with 120-ft intervals between lines. The bituminous-fiber tiles

with fiberglass filters were installed with perforations up. The clay and concrete systems were surrounded with a washed-gravel filter. The lines were 1250 ft long. These three tiles were installed as part of a long-term experiment to determine the longevity and effectiveness of these materials over an extended period of time (it is expected that observations will continue over a period of 20 to 25 years).

The first observations, in 1966, represent initial tests of the three materials. The effectiveness of these lines will be recorded periodically to show how the flow changes with time. In addition, segments of the lines will be examined to see how they stand up under a long period of use. This report gives the initial comparison of operations of these three different types of material.

A description of the soils of this area (made before tiling) was based on three subareas: (1) silty clay loam, fine sandy clay loam, and sandy clay loam in the first 4 ft, giving way to a dense clay which continued to 10 ft; (2) clay loam and dense clay throughout the entire 10 ft, with one area of sandy loam at 5 to 6 ft; and (3) holes dug in subarea 3 indicated that further subdivision should be made to describe the soils adequately: part contained clay loam throughout the 10 ft, while nearby, silty clay loam in the

first 3 ft gave way to fine sandy loam down to 10 ft. Average permeability values, obtained for the different subareas of the experimental plot, varied according to the materials present, and were generally low except for small isolated areas.

During April 1966, levees were constructed in the field which isolated the pairs of tile and segmented each pair into a south third, a center third, and a north third, as shown in the test plot diagram. The south third was flooded first by allowing water to spill from one segment to the next. A steady flow was maintained across the ponds to keep the ponds full. Each third was then allowed to drain before the next was filled.

Soil moisture and conductivity records of saturated soil pastes were obtained to 5 ft of depth prior to and following the ponding operation in each third. Tile outflows were recorded twice daily with 4-inch, V-notch weir inserts placed in the ends of the tile. Electrical conductivity of the tile effluent was recorded twice daily. Twenty-four samples of 700 cc tile effluent were evaporated to define total salt content as a function of electric conductivity. Total salt removal was then calculated.

TABLE 1. EFFLUENT AND SALT REMOVAL IN EACH ONE-THIRD SEGMENT OF TILE LINES, IN METRIC TONS

	Type of tile						Total
	Bituminous		Clay		Concrete		
	1	2	1	2	1	2	
Metric tons							
South third:							
Water outflow	120	190	121	102	158	458	1149
Salt removal	0.88	1.27	1.21	0.85	1.33	2.03	7.58
Center third:							
Water outflow	227	515	431	383	391	583	2530
Salt removal	1.68	3.14	2.64	2.64	3.18	3.69	16.97
North third:							
Water outflow	215	404	320	267	425	410	2041
Salt removal	2.88	3.36	3.21	3.02	3.93	3.90	20.30

TABLE 2. DIFFERENCE IN SATURATION EXTRACT OF SOIL BEFORE AND AFTER LEACHING AT 15 AND 60 FT FROM TILE LINE. VALUES INDICATE A REDUCTION IN MMHO/CM UNLESS PRECEDED BY A (+), AND ARE MEANS OF 5 SAMPLES

Depth ft	South third		Center third		North third	
	15'	60'	15'	60'	15'	60'
0-1	0.7	0.9	0.8	0.2	2.6	1.2
1-2	0.2	+0.1	1.7	+0.2	.9	0.5
2-3	+0.1	0.2	1.3	+0.1	1.1	0.0
3-4	+0.6	0.4	+0.5	+0.6	1.1	0.0
4-5	+1.5	1.0	+0.2	+1.1	1.6	1.3

TABLE 3. COMPARISON OF SATURATION EXTRACTS IN MMHO/CM FROM SOIL DIRECTLY OVER TILE, 15 FT FROM TILE, AND 60 FT FROM TILE AFTER LEACHING IN NORTH THIRD (MEAN OF FIVE SAMPLES)

Depth ft	Above tile	15 ft	60 ft
0-1	4.2	8.9	10.4
1-2	4.9	9.0	8.8
2-3	6.3	10.7	10.9
3-4	5.9	11.3	11.9
4-5	6.7	11.3	11.4

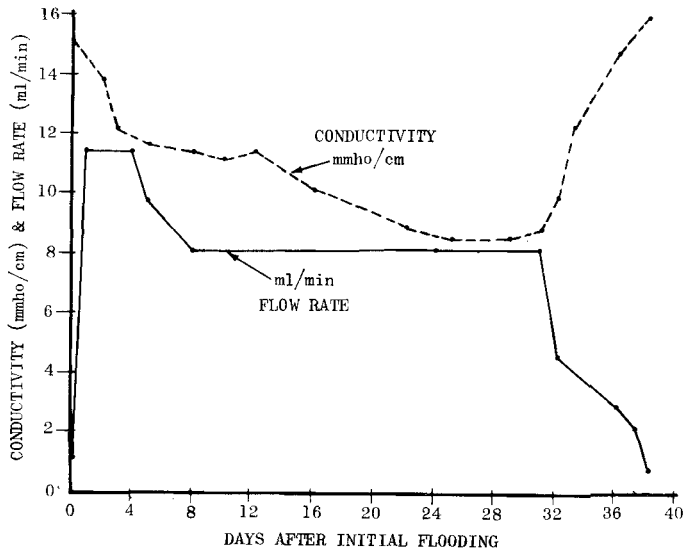
TABLE 4. PARTITION OF WATER LOSS IN THREE TILES FROM LEACHING PONDS IN MM PER DAY

	Bituminous tile	Clay tile	Concrete tile
South third:			
Rate of fall of pond	17.2	17.5	20.4
Out of tile	1.5	1.0	2.4
Est. evap. (0.7 pan)	7.8	7.8	7.8
Other than tile	7.9	8.7	10.2
Center third:			
Rate of fall of pond	18.9	18.9	18.6
Out of tile	2.2	2.6	3.1
Est. evap. (0.7 pan)	8.2	8.2	8.2
Other than tile	8.5	8.1	9.3
North third:			
Rate of fall of pond	15.5	16.8	15.3
Out of tile	4.2	3.9	3.5
Est. evap. (0.7 pan)	8.6	8.6	8.6
Other than tile	2.7	4.3	3.2

# DRAIN TILES

## Valley

CONDUCTIVITY AND FLOW RATE AFTER INITIAL FLOODING OF TILE DRAIN TEST PLOTS, IMPERIAL VALLEY FIELD STATION



The graph shows flow and electrical conductivity data for the tile effluent from a single tile line in the center third of the area. The other tiles showed the same general inverse relationship between electrical conductivity and both rate and period of flow. The relationship of electrical conductivity to rate and duration of flow was unique for each tile line and no general relationship could be established. This undoubtedly was the result of a unique combination of hydraulic conductivities along each tile line. Areas of high hydraulic conductivity tended to dilute the salinity in the areas of low hydraulic conductivity. The high initial rate of effluent reflects the method of filling the ponds. A flow of 2 cu ft per second was used for the first five days until the ponds were full. The rate was then dropped to 1/2 cu ft per second to maintain a continuous flow across the ponds to establish a constant surface level. The surface level dropped when the flow was reduced and the tile flow dropped at that time.

Table 1 shows the total water and salt removal from each of the six tiles. Differences in outflow between thirds of the same tile line were greater than differences between pairs of tile, and differences between pairs of tiles of the same pair were of the same order of magnitude as those between pairs of different types.

Table 2 shows soil salinity changes

from saturation extracts taken before and after flooding. Changes in salinity were quite small in the body of soil between tiles and may have been accounted for by the initial wetting.

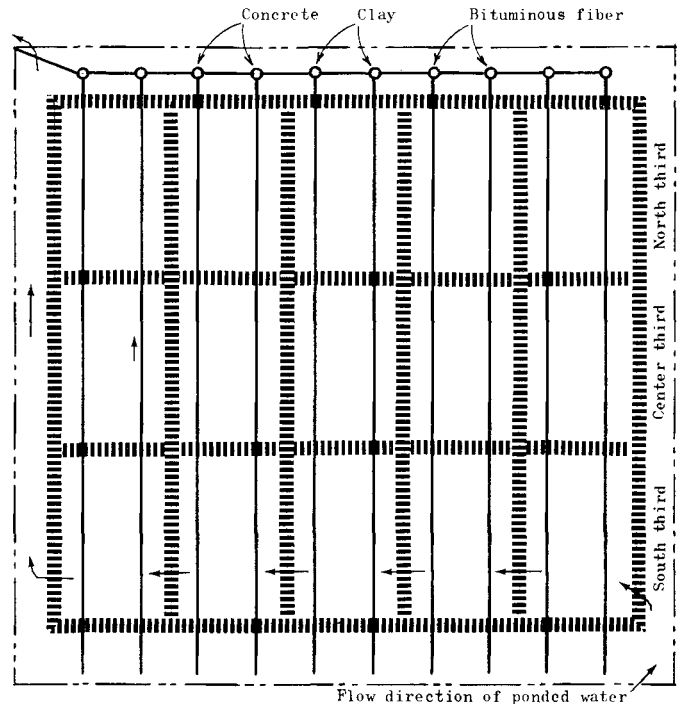
Table 3 presents the saturation extracts taken in the north third from directly over the tile, 15 ft from the tile, and 60 ft from the tile line. Salinity in the disturbed trench above the tile line had about one-half the value of the samples taken farther to the side of the tile line.

Table 4 shows the rate of fall of the ponds after water was turned off. This drop in level was partitioned into three quantities: The measured outflow from the tile, the loss due to evaporation, and the remainder which was lost to deep or lateral seepage. Evaporation loss was 0.7

times that from a weather bureau pan.

In a second method used to check the evaporation estimates, electrical conductivity of the pond water taken from the north third when the water was turned off was recorded at 2.02 mmho per cm. Fourteen days later the conductivity was 4 mmho per cm or twice the value, indicating one-half of the water had evaporated. The drop in pond level had been 220 mm. Of this amount 110 mm was due to evaporation at 8.0 mm per day, as compared with the pan estimate of 8.6 mm.

*Frank E. Robinson is Assistant Water Scientist and James N. Luthin is Professor of Irrigation and Civil Engineering, Department of Water Science and Engineering, University of California, Davis.*



EXPERIMENTAL LAYOUT OF TEST PLOTS COMPARING THREE COMMERCIAL DRAIN TILES IN A HEAVY CLAY SOIL AT THE IMPERIAL VALLEY FIELD STATION

- Levee
- Tile line
- Field boundary
- Manhole over tile

Tile drain test plots during flooding at Imperial Valley Field Station.

