Concrete Pipe

systems economical and feasible on most farms

A. F. Pillsbury and M. L. Hood

Nonreinforced concrete irrigation pipe systems for the distribution of water on surface irrigated farms are in almost universal use in the south coastal basin of California.

Such systems permit easy control of the water, almost complete prevention of seepage and evaporation, distribution without appreciable loss of land, and are quite permanent. Maintenance problems are, or should be slight, and such systems are economically feasible on most farms.

Hydrostatic pressures are limited to about 25 feet of water, but seldom exceed 10 or 12 feet. Prefabricated sections generally are in 2½ to three feet lengths with tongue and groove joints which are mortared together. The inside diameters of the standard sizes are six, eight, 10, 12, 14, 16, 18, 20 and 24 inches. Use of the 20- to 24-inch sizes is less common, and involves more hazard of breakage than the smaller sizes.

Usual distribution is from or near the high corner of the farm. Large diameter —30″ to 42″—pipes, laid vertically on a freshly poured concrete base, form stands which serve as *1*, regulating structures to prevent high hydrostatic pressure; *2*, vents to release air from the lines, especially at high points; *3*, diversion structures, such as with gate valves mortared to the pipe lines radiating out from a stand; *4*, settling basins and sand traps; *5*, surge chambers; *6*, metering structures. Where limitation on the function of a given stand permits, its diameter may be cut down to the diameter of the pipe.

Hydrants, of many types, are placed on the tops of risers. The hydrant valves usually are horizontal discs with a ring of packing material around near the periphery. The disc screws down onto a machined ring seat which is mortared to the riser, and to which is fastened the spider on which the disc screws up or down. For flood irrigation these are usually called, alfalfa valves and open right to the ground surface. For furrow irrigation the valves, orchard valves, distribute into a larger diameter vertical pot, which has a series of sheet metal slide gates at regular intervals around the pot, one to four inches above ground water, for regulating flow into individual furrows. A variation of the latter utilizes a steel riser with a globe valve at the top discharging into sheet metal pipes six to 15 feet long, on swivels, and with sheet metal gates at regular intervals. Thus, these arms can be laid across the furrows, discharging directly into them without hand work, and can be raised out of the way, chained to a post, when not in use. Closed pot hydrants with the top of the pot sealed over are also used where grades are flat. They are more difficult to regulate, but have the advantage of keeping out leaves which may plug the slide gates, and do not require orchard valves.

Where the pipe line grade is such as to cause appreciable variation in pressure at the hydrants, or such that water may not at some points be of adequate pressure to flow from the hydrants, certain devices must be utilized to give frequent pressure regulation.

Overflow pot hydrants are especially adaptable to low-flow furrow irrigation on steep slopes. Often the risers are reversed—inflow on outside—but air is entrapped in the overflow water causing operating difficulties.

Overflow stands are common with larger flows. The by-pass gate valve is practically a necessity because of the large amount of air entrapped in the small downpour section. Where the gate valve is not necessary for other reasons, the overflow stand with a wide overpour lip and the large cross-sectional area of the downpour section—with consequently less air entrapment—is preferable. Also, operation is simpler.

Float valve stands have many advantages, especially in the simplicity of regulation. There are two types of float valves on the market which appear to give good service, and their use is extending quite rapidly. With float valves, whenever a hydrant opening is changed, that change in the flow is automatically corrected all the way upstream in the pipe lines.

Pipeline Failures Avoided

Most systems are used year after year without giving trouble. There are always a certain number of failures, and these fall into the following categories:

1. Development of longitudinal cracks in the pipe, principally in the top and bottom.

2. Telescoping of sections together.

3. Development of circumferential cracks.

4. Pushing of the pipe into stands.

5. Deterioration of the concrete.

The first four types of failure are closely related. The fifth has been found to be caused by the careless use of certain fertilizers added to the water. Also, in one known case, a patented soil amendment, added to the water, caused a release of sulfuric acid vapor along the invert of a pipe, causing deterioration. The following fertilizers might give trouble:

If ammonium sulfate must be added to the water before it is run through a pipe line, the concentration should never exceed 0.1%, and lines must be flushed thoroughly immediately thereafter.

Ammonium nitrate is relatively safe, but concentrations should not exceed 1%, and the lines should be flushed afterward.

Both the cause of most failure and the prevention of some failure are related to that property of concrete which causes it to expand when wet, and to contract on drying. Concrete also is affected by temperature, having a property of expansion with heating. Circumferential cracks are caused by a decrease in water or soil temperatures, or by the drying out of the pipe. The only way to prevent such cracks is to pre-stress the pipe longitudinally. Fortunately, this is done by the tendency of the pipe to expand on wetting, with the pipe being placed dry.

The axial stress set up in pipe by the natural restraint of longitudinal expansion is the principal cause of the longitudinal ripping, and also of the telescoping and the pushing of pipe into structures. For a long time the possibility of axial stress causing longitudinal cracks was doubted, but recent experiments have shown it to be true. Other wetting strains can occur as from a change in moisture gradient through a pipe wall, or from a wetter condition around the bottom than around the top of a pipe. These combine to produce failure, and the latter causes the cracks to be located normally in the top and bottom of the pipe. The solution to the problem of occasional failure comes, not in eliminating wetting expansion, but in keeping it from becoming excessive.

Investigations point the way towards obtaining designed and installed lines that will not be susceptible to failure.

Rich concrete mixes in the pipe should be avoided. The mix preferably should not be richer than 4.5:1 for the aggregate: cement ratio by weight as rich mixes cause greater stresses to be set up when expansion is restrained. The pipe should be fabricated in accordance with the American Society for Testing Materials Specification C-118. Much of the pipe made does not fully adhere to these specifications.

There may be advantage in designing pipe lines so that water always stands in

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WATER

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water are not carefully examined when additional supplies are secured.

Ground Water and the Courts

Until recently the sole limitations imposed by the courts upon rights to pump were that the water should be put to a reasonable beneficial use, and that, in the event of a shortage, water could not be exported from a ground water basin. Even this latter rule was modified by the provision that if a party other than an owner of lands overlying the ground water basin obtained water for a period of five years without being served with an injunction, his right was secure. Neither of these rules provides an effective control over competitive pumping and overdraft.

This year the California Supreme Court has attempted a more satisfactory solution. In an important decision—the so-called Raymond Basin Reference Case—it was ruled that mutually prescriptive rights had been established as between landowners and others pumping from an overdrawn basin, and draft was limited to *safe yield* by a proportionate reduction of pumping by all users.

Important Problems Remain

The court has power to allocate rights only in cases brought before it. Should the entire burden of apportioning pumping rights be left to costly litigation? Should legislation provide administrative control over overdraft? If so, what form should such legislation take? Is an all-round reduction of pumping rights the most desirable basis economically and socially for preventing overdraft? Is a period of five years appropriate for establishing whether pumping by outside users is causing overdraft?

There is an elaborate system of statutory and administrative controls upon the use of surface waters. Social institutions governing the use of ground water are at once less diverse and less adequate.

Further Studies Needed

Most of the research relating to ground water problems in California has been concerned with the physical aspects of overdraft. While it is necessary to continue such studies, the most urgent need is an understanding of the economic and social causes and effects of overdraft in their regional setting and historical development. With such an understanding, the various attempts which have been made to deal with the problem of overdraft, and the reasons for their success or failure can be investigated. Possible improvement of the social institutions under which ground water is used in California might then be explored. The Giannini Foundation is undertaking a series of ground water studies with this end in view.

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The first of the Giannini Foundation Ground Water Studies, "Ground Water in California—the Present State of Our Knowledge," may be obtained without cost by addressing the Agricultural Information Office, 22 Giannini Hall, University of California, Berkeley 4, California.

MECHANIZATION

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Farm tractors have also received considerable attention in recent years. Much interest has developed in new small general purpose tractors. The latest has a rear-mounted engine which gives the operator full vision of the attached equipment. These small units have a full complement of attached tools and are adapted to the 40- and 50-acre farm.

Hydraulic controls for both mounted and trailed machines give the operator complete finger-tip control of his implements. The shifting of a simple control raises or lowers a plow or angles a disk harrow through a properly placed hydraulic cylinder.

While many of California's field crops are lending themselves to mechanization, the fruit and vegetable industry still has a long way to go. Many operations connected with the fruit industry can never be mechanized because human judgment is necessary in such operations as pruning, thinning, and harvesting.

A successful onion harvester has been developed recently and a group of flower bulb growers in San Diego County plan to try it hoping to solve some of their harvest problems with it.

An electronic grader and color sorter is under development. The machine, while originally designed to separate lemons into six sizes and five color grades, may have other applications.

The sorting of adobe lumps out of beans is no problem with a new machine that uses the difference in skin friction between the two for effecting a separation.

These are some of the many significant changes in the farm equipment field as well as in the agricultural practices in California during the past 20 years.

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The foregoing report is a condensation of a paper presented before the California Farm Equipment Dealers Association in Santa Barbara, November 11, 1949.

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them, but this has not yet been verified. It may be desirable to avoid the condition where the pipe is alternately wet and dry. On slopes, this can be done by using float valve stands. Where this is not practical, loose fitting but rather air-tight covers placed on top of all stands should have somewhat the same effect. These should cut down on the circulation of air through an empty or partly full pipe, this permitting the building up of humidity in the pipe. Humidity without actual wetting is surprisingly effective in causing some wetting expansion. Expansion at constant temperature has even been observed when the relative humidity was increased from 32% to 48%.

As the pipe is laid, an initial backfill should proceed behind the pipe, say, not less than two sections nor more than five sections behind actual laying; this initial backfill to cover the pipe to a depth of at least six inches. If the weather is humid and somewhat overcast, or if the initial backfill soil is somewhat moist—above the permanent wilting percentage—no other precautions are necessary. Otherwise, the initial backfill soil should be wet—from a tank truck if necessary. Such precautions will take the peak off of wetting expansion, but a desirable amount will still be retained. The pipe should be dry at the time of laying.

Pipe lines should be plugged as much as possible to prevent air circulation during laying. Open ends should be plugged when the work stops for an hour or more, and should be kept plugged until water is placed in the pipe line four days to a week following laying.

Expansion joints and presoaking of the pipe before laying are to be avoided. Riprings imbedded in the pipe are ineffective.

More trouble is experienced in adobe clay soils than in other types. In such soils it is suggested that a 4-inch layer of sand or sandy loam be placed on the bottom of the trench, and, as much as possible, similar soil be used for the initial backfill. Such precautions should prevent most such trouble.

Other procedures and practices—such as uniform line and grade, at least two feet cover over pipe, banding—are more or less customary.

Plain concrete pipe lines have been and still are the most desirable and efficient means of distributing irrigation water on the farm for surface irrigation. Where water is scarce, as in southern California, their use is almost axiomatic. Previously there has always been a small percentage of failure of such systems. Recent investigations of the College of Agriculture point the way to slight modifications in

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The part that light of varying intensity may play in retarding or hastening the ending of the rest is still not very clear. It may at winter intensities and duration be a retarding influence and become a stimulating influence at the higher intensities and longer duration of spring and summer.

The gardner and orchardist in regions of mild winters is thus confronted with a rather complicated situation involving temperature, light, variation of response of different kinds of plants, and possibly other factors, all of which affect spring growth. It appears clear from experience, however, that shade in winter is beneficial for plants with strong rest periods. It seems a reasonable deduction from the experimental results described above that plants subjected to fluctuating outdoor conditions may require a longer exposure to break the rest of buds than would be required under continuous low temperature.

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The above progress report is based on Research Project No. 989.

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fabrication and installation procedure that should largely eliminate such failure at no appreciable increase in cost.

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SOILS

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applied fertilizer could be expected—provided other elements were not limiting.

No-nitrogen yields above 50% indicate high nitrogen supplies and little chance of field response to fertilizer.

Soils giving a no-phosphorus yield of 20% or less are so low in available phosphorus that they will, as a rule, produce a field response to applied fertilizer where other nutrient elements, specific soil conditions and water are not restrictive.

Phosphate responses in the field were especially noticeable during the cooler seasons of the year.

Soils producing no-phosphorus yields above 30% probably will not justify phosphate fertilization.

Low phosphate levels appear to be widespread in California, especially in hardpan soils and in the soils in the hills and mountains.

In contrast, the recent alluvial soils are somewhat better supplied with available phosphorus and have the additional advantage of having great depth which provides a large nutrient reservoir.

Available phosphorus in soils with either pronounced acid reaction or with pronounced basic—alkaline—reaction tends to be in low supply. Soils which are neutral or with only slight acid or alkaline reactions are, on the average, better supplied with available phosphorus.

Of the 105 soils tested which had a pH—the measurable acidity and alkalinity—of below 5.9, which indicates strong acidity, 79% were low in available phosphorus.

Of the 20 soils tested which had a pH of above 8.3—markedly alkaline—80% were low in available phosphorus.

Of 116 soils slightly off neutral only 26% were found to be low in available phosphorus.

Nearly all of the soils investigated appear to be well supplied with potash for the requirements of the crops used in this study.

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DAIRY FARM MANAGEMENT IN CALIFORNIA, by Arthur Shultis and G. E. Gordon. Ext. Cir. 156, September, 1949.

SELECTIVE WEED KILLERS, by Alden S. Crafts and W. A. Harvey, Ext. Cir. 157, September, 1949.

GENERAL-CONTACT WEED KILLERS, by Alden S. Crafts, Ext. Cir. 137, revised October, 1949.

GROUND WATER IN CALIFORNIA—The Present State of Our Knowledge, by S. V. Ciriacy-Wantrup and Patricia McBride Bartz. A special publication by the Giannini Foundation which is available only by addressing a request to the Agricultural Information Office, 22 Giannini Hall, University of California, Berkeley 4, California. The publication is free.

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