

Concrete Pipe Irrigation

successful water distribution systems can be improved further by more adequate designs and installations

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Plain concrete pipe systems carry most of southern California's irrigation water but still can be improved in design and installation.

Improvement is possible in four general areas: water regulation can be simplified; expansion and contraction failures reduced; concrete qualities improved; and hydrant capacity increased.

Regulation

The widely used open systems on steeper slopes have been unsatisfactory because of surge problems, regulation difficulties, inflexibility of deliveries, and the necessity of providing for tail water wastage. It is doubtful whether any open-type system will ever be fully satisfactory where grades are steep enough to require drop structures.

The alternative is to design a semi-closed system, with float valves replacing the overpour features of the periodic stands of the open system. Semi-closed float valve systems on farms, though limited in number, have proved their value on the steeper slopes. There is no tail water; pressure and rate of flow is always controlled; any change in any portion of the system causes completely automatic adjustments all the way upstream; and pressures are kept within the allowable limits for plain pipe.

Concrete pipe is well on its way to supersede use of canals and ditches on new district systems, and drop structures will be common. The semi-closed system—untried for district distribution—should be given a thorough trial before such design proceeds further. It would give the farmers much more flexibility in handling the water and should result in higher application efficiencies.

Expansion and Contraction

The fact that wet concrete expands and drying concrete contracts has a vital effect upon pipe. When pipe is moistened after laying and backfill, longitudinal or axial wetting expansion is almost completely restrained. Compressive stresses develop, which are partially the cause of pipe ripping. Experiments in a testing machine proved that failure from axial stresses invariably took the form of longitudinal cracks.



Open pot hydrants being installed for a future vineyard. These hydrants permit small flows in single furrows along each side of the row. The vines will soon require that more soil area be wet. A new water supply is available but it contains almost four times the concentration of salines. The farmer must flood in strips almost 10 feet wide to control salinity. For this, the open pot hydrants are inadequate.

But longitudinal wetting compression would not alone cause ripping. Accompanying it are bending stresses set up by differences in wetting around the circumference of the pipe. Such circumferential bending stresses account for the rips being in the top and sometimes also in the bottom of the pipe, and for the fact that large pipe sizes are more susceptible to failure than smaller sizes.

Axial compression tends to reach a peak in about two weeks after wetting, and circumferential stresses apparently after a much shorter period. Also, no possibility can be foreseen that pipe once laid and covered can ever be as dry as before laying. Therefore, rips probably always occur within a few days to two weeks after laying.

Effect of Moisture

Lines may rip before water is turned in. The moisture to cause expansion then comes from the joint mortar or from moisture in the soil.

Moisture in the soil probably is transferred in the vapor phase. This possibility was investigated by measuring length changes in concrete pipe placed in a constant temperature room where relative humidity could be varied between 32% and 100%. The results showed that rate of length change increased with increasing humidity. Humidity was increased in steps, one following immediately after the

other, then decreased in one big step, after which the pipe was immersed. Expansion was much more rapid with immersion but it can be estimated that expansion from a single jump change in humidity—as from 45% to 95%—might have been at about one third the immersion rate. Obviously relative humidity has a marked effect on expansion.

When weather is dry just prior to laying, and the initial backfill soil is dry, pipe will be subject to excessive wetting expansion. If any moisture is present, it will probably be around the invert where there is more joint mortar, and in the trench bottom soil. These are prime conditions favoring ripping.

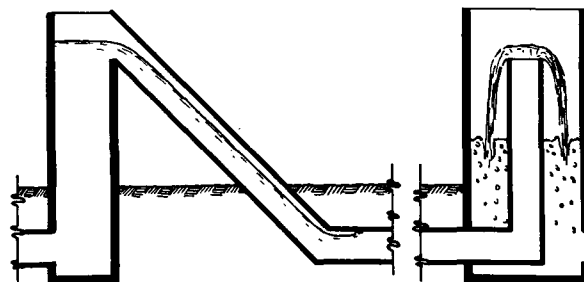
Effect of Cold Water

Pipe systems often develop bad leaks when cold water is run through them in winter. Usually the breaks are circumferential cracks caused by thermal contraction, but a few are old rips that previously did not open up. Contraction leaks appear more serious where the pipe line is empty and was dried out prior to being filled with cold water. Because of danger of such leaks, as much longitudinal compression as possible should be retained in a line. Low temperatures will then merely tend to relieve this thrust rather than to open up cracks.

There is one more condition which affects expansion and contraction: the drying out caused by a draft of air circulating through a line. Experiments showed that the intrados—inside surface—dries quickly, and that the extrados—outside surface—also dries and

Continued on page 12

Two types of stands which, on small farm systems, have been fairly successful in eliminating surges by giving the air more opportunity to escape.



PIPE

Continued from page 3

shrinks, even when it is in contact with somewhat moist soil.

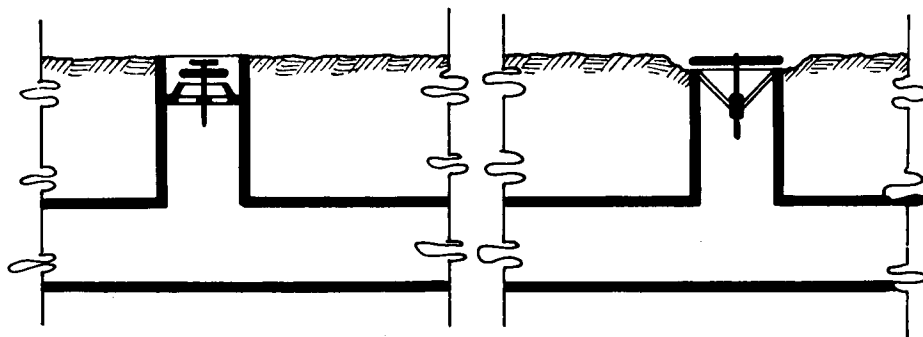
Generally, rips and cracks can be largely prevented by always using moist soil for the initial backfill, following two to five lengths behind laying; designing systems so that air can not circulate through the pipes, and preventing air circulation during installation; and constructing all stands before the pipe is laid, and tying the pipe into such structure promptly after laying. Prompt filling of a new line with water is also desirable to prevent cracks.

Concrete Qualities

General experiences and experimental studies point to the importance of density in concrete toward making for permanence.

Even if high strength is not needed in thin shelled plain concrete pipe, emphasis should be placed on high quality—density and imperviousness. Good grading of the mix, good compaction, and good lubrication of the mix—possibly through air entrainment—are important.

Farmers can use the absorption test to check the quality of pipe they are purchasing. Simply, in this test a fragment of pipe is boiled five hours in water, weighed wet, then dried to constant



Orchard valve hydrants—left—are commonly installed where alfalfa valve hydrants—right—should be installed for flooding irrigation. With the same size riser, the latter may permit almost three times the maximum flow of the former.

weight in a 110° C oven. The weight loss should not exceed 8% of the dry weight. Experiments showed that this simple test correlates absorption with bulk density of the concrete.

Hydrant Design

Of the two common hydrants for flooding irrigation, the alfalfa valve and the orchard valve type, the latter is neater—there is less erosion around the hydrant. However, this hydrant may have as little as one third the capacity of the alfalfa valve type of comparable size. If the alfalfa valve is placed low—several inches below the soil surface—erosion is usually not too severe. In easily eroded soils old tires or a short length of larger pipe can

be buried around the hydrant and provide protection. Normally, the entire capacity of the pipe line should be available from each hydrant, and it would be shortsighted and false economy to under-design hydrants.

Large capacity is becoming increasingly important as the trend is away from furrow and toward flooding irrigation to provide more water and avoid salinity problems. In arid regions rainfall is often inadequate to accomplish sufficient leaching, so irrigation must be used to control salinity.

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PASTURE

Continued from page 6

more mature the legumes—higher in moisture than the grasses—increased proportionately as the clippings became less frequent. This about offset the expected differences in dry matter with increasing maturity.

The protein percentage was highest in alfalfa-grass mixtures, lowest in the trefoil-grass, with ladino ranking in between. All mixtures showed a considerable decline in protein content as the clipping intervals became greater. This is not too significant because even the

lowest protein percentage for the infrequent clippings is large enough to supply far more than the requirements of the grazing animal.

As the drop in protein percentage is associated with an increase in fiber content, the digestibility of the feed may be lowered. The question of how far yield should be sacrificed to increase quality is still unanswered.

It is not known at this time how livestock will gain under a rotation scheme which allows a considerable amount of topgrowth.

The concentration of enough stock on each pasture to graze it down quickly

and evenly is an essential part of a rotation grazing system. If grazed down too slowly, much of the pasture's grass will be trampled and fouled by manure droppings.

Overgrazing will reduce pasture yield; undergrazing will permit some of the grass to become more mature, and this will result in losses in feed quality and livestock gain.

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Clover grazed at intervals of four or five weeks will attain a height of 12 to 15 inches. The stake in the picture is 15 inches tall.

