WATER OPERATION AND MAINTENANCE

BULLETIN NO. *109*

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IN THIS ISSUE

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The Water Operation and Maintenance Bulletin is published quarterly for the benefit of those operating water supply systems. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the reports herein concerning laborsaving devices and less costly equipment and procedures will result in improved efficiency and reduced costs of the systems for those operators adapting these ideas to their needs.

To assure proper recognition of those individuals whose suggestions are published in the bulletins, the suggestion number as well as the person's name is given. All Bureau offices are reminded to notify their Suggestions Award Committee when a suggestion is adopted.

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Division of Operation
and Maintenance Technical Services
Engineering and Research Center
Denver, Colorado 80225

Scoggins Dam outlet works control house and fish handling structure, Tualatin Project. The spillway and top of the dam are visible on the left.

SI METRIC

WATER OPERATION AND MAINTENANCE
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INTRODUCTION

The article, "ABC's of PVC Installation," starting on page 1, contains information for anyone seriously considering purchasing PVC pipe for below ground installation of an irrigation system.

The use of liquid calcium chloride on unpaved roads is saving Ogle County money, as well as reducing dust during the summer months, and controlling the ice problem in the winter. See page 6.

The article beginning on page 9 describes how the maintenance crew at the Oroville fish hatchery devised protective covers for the windows of the fish ladder, yet providing clear viewing for fish watchers.

Premix cement and rain? A simple, fast, inexpensive, and successful method of stabilizing sandy soil slopes on bridge approaches is described on page 14.

Because epoxy is immune from salt attack, it has proven to be an effective means for resurfacing bridge walkways–see page 15.

Metric is here at the San Luis Field Division. The article on page 16 describes the design of a dial indicator on check gates, displaying both metric and standard values.

Page 19 points out the advantages of a fall routine maintenance program of irrigation equipment.

Getting a job done safely with the right struck tools is pointed out on page 21.

ABC'S OF PVC INSTALLATION[1]

by Ron Ross

When you install an irrigation system, your primary thoughts are no doubt on the above-ground portions of the system, since that's the end you're counting on for improved profits. Yet, correct selection and installation of the below-ground part of the system–the mainline–is critical for success.

A substantial percentage of new mainline is PVC (polyvinyl chloride). PVC is continuously extruded into seamless lengths which are strong, chemically resistant, have low friction loss and are lightweight for ease of handling.

Whether or not you install your own PVC, or have it installed by a professional, there are certain characteristics unique to PVC which will be helpful to know, points out Darnell Lundstrom, North Dakota State University Extension Agricultural Engineer.

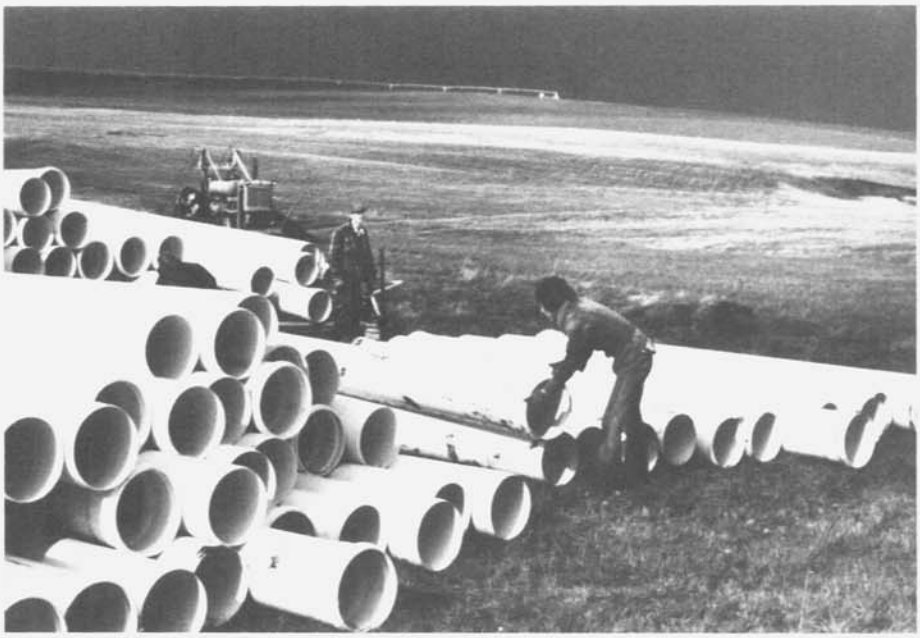

Figure 1.–Plastic pipe is stacked, ready for field installation as a major conveyance of water for this farm. A center pivot is in the background.

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[1] Reprinted by special permission of the Editor, Irrigation Age, from March 1979 issue.

Pressure rating.–PVC pipe may be designated as either low head or high head (more than a 15-m (50-ft) head). Pressure ratings may be given in meters (feet) of head, class of kPa (lb/in^2), schedule or SDR (Standard Dimension Ratio).

By definition, 0.7 m (2.3 ft) of head equals 7 kPa (1 lb/in^2) of pressure.

Class or kPa (lb/in^2) designation refers to a pressure rating in kilopascals (lb/in^2)–see table 1. The operating pressure on the job, including surges, may equal the class rating, but care must be taken to insure that all surges are accounted for. A competent design engineer should at least check all system layouts. If surge pressures are not calculated, the design operating pressure of the pipeline should not be over 75 percent of the pressure rating of the pipe.

Schedule denotes a plastic pipe which has the same outside diameter and wall thickness as iron or steel pipe of the same nominal size (see table 2). SDR is the ratio of the outside pipe diameter to the wall thickness (table 1). There are pressure rating differences between types I and II and grades I and II.

Table 1.–*Maximum operating pressure for class and SRD rated PVC pipe*

Pipe rating designation	Maximum operating pressure including surges	
	kPa	lb/in^2
Class 80	550	80
Class 100	690	100
Class 125	860	125
Class 160	1100	160
Class 200	1380	200
Class 250	1725	250
Class 315	2170	315
SDR 81	345	50
SDR 51	515	75
SDR 41	690	100
SDR 32.5	860	125
SDR 26	1100	160
SDR 21	1380	200
SDR 17	1725	250
SDR 13.5	2170	315

Table 2.—*Maximum operating pressures for schedule 40* and schedule 80* PVC pipe*

Diameter		Maximum operating pressure							
		Schedule 40				Schedule 80			
mm	in	kPa		lb/in²		kPa		lb/in²	
75	3	1790	(5790)	260	(840)	2550	(8270)	370	(1200)
100	4	1515	(4895)	220	(710)	2205	(7170)	320	(1040)
150	6	1240	(3860)	180	(560)	1930	(6135)	280	(890)
200	8	1100	(3445)	160	(500)	1720	(5445)	250	(790)
250	10	965	(3100)	140	(450)	1585	(5170)	230	(750)
300	12	895	(2895)	130	(420)	1585	(5030)	230	(730)

Figures in parentheses are 60-second burst pressure test values for schedule 40 and 80 PVC pipe.

* Type 1, grade 1, at 23 °C (73.4 °F).

Diameters and lengths.—Either an IPS or PIP size may be used. The IPS refers to plastic pipe which has the same outside diameter as iron pipe of the same nominal size. The industry size designation for plastic irrigation pipe is PIP. When obtaining cost estimates from different firms, be sure all estimates are in the same size designation. Pipe size should be large enough so that the water velocity never exceeds 1.8 m/s (6 ft/s). This is to avoid excessive friction losses and surge or water hammer problems.

Pipe sections are available in lengths of 6 m (20 ft), 9 m (30 ft), 10.7 m (35 ft), and 12 m (40 ft). Diameters available are 100 mm through 355 mm (4 in through 14 in) for low head (15 m (50 ft) and 12 mm through 305 mm (1/2 in through 12 in) for high head pipe.

Joints and connections.—Solvent welds and rubber gasket joints are commonly used. Rubber gasket joints may be the bell and spigot type or a separate twin gasket coupler for use with plain end pipe. Solvent weld joints are not recommended if the pressure requirements exceed 345 kPa (50 lb/in²) and the pipe diameter exceeds 100 mm (4 in). Solvent welding requires extreme cleanliness and the material has temperature and humidity precautions which must be observed.

Valve protection.—Install a check valve between the pump discharge and the pipeline to prevent backflow when the pump stops. This is extremely important on installations where fertilizer or herbicides are injected through the sprinkler irrigation systems. The EPA (Environmental Protection Agency) states that no pollutants or contaminants may enter an irrigation well. The check valve should be designed to close without slamming shut.

Install pressure relief valves or surge chambers at both ends of the pipeline. They should be sized at 6.25-mm (1/4-in) diameter for each 25-mm (1-in) diameter of pipe size and set to open at a pressure no greater than 34 kPa (5 lb/in^2) above the pressure rating of the pipe.

Air vents and vacuum relief valves must be placed at all high points in the line and also at the pump between the discharge and the check valve. On long flat lines, install air vents at one-third the distance from each end. The size of air vents and vacuum relief valves should be no smaller than 25-mm (l-in) outlets for 127-mm to 200-mm (5-in to 8-in) diameter pipe and 50-mm (2-in) outlets for 225-mm to 380-mm (10-in to 15-in) pipe. Be sure that it is the valve opening size and not the thread size when you buy a certain size valve.

Placement.–The PVC pipe may be buried in the normal frost zone providing the pipe is sloped to permit drainage to a low point in the line for pump-out. A minimum of 760-mm (30-in) of cover over the pipe is required for protection against heavy machinery. A trench at least 150 mm (6 in) wider than the diameter of the pipe is needed. Where possible, assemble the pipe above ground and then place it in the trench. If the trench curves, assemble the pipe on the outside of the curve to eliminate the possibility of it being too short. Spray a small amount of paint on each joint of gasket pipe before dropping it in the trench so that you can see if any joints have slipped apart.

Install concrete thrust blocks at each change in direction (tees, elbows), changes in pipe sizes, and at stops or ends to prevent the pipe from coming apart during operation.

Each thrust block should be large enough to adequately bear the thrust of the water in the pipe. In some installations, thrust blocks may hold back as much as 2.3 to 2.7 megagrams (5,000 to 6,000 lbs) of pressure. So, be sure the exact size is calculated for each case by a qualified engineer or technician. Construct a block on the complete outside edge of an elbow and the downstream size of a tee.

Testing.–Thoroughly test a line for leakage before backfilling. With gasket joint pipe, it's necessary to partially backfill before testing to hold the line in place. Cover only the body of the pipe and leave all joints exposed. Fill the line slowly and after filling, work up to design pressure over a 15- to 20-minute period.

Backfilling.–Hand tamping or water packing may be used. Use water packing only on rapidly draining soils. Use only fine grained material which is free of rocks and clods for the initial coverage of the pipe. When water packing is used, the pipeline must be filled with water before beginning the backfilling. Backfill about 200 mm (8 in) over the pipe, then add water to thoroughly saturate the initial backfill without overwatering. Close the valves so the pipe remains full and allow the wetted fill to dry until firm before completing the backfill.

Hand tamping involves tamping (haunching) the initial fill in 50-mm (2-in) layers to at least 150 mm (6 in) above the pipe to a soil density of at least 85 percent of the undisturbed sidewalls.

Always fill low head pipe with water prior to either type of backfilling to avoid serious damage to the pipe by crushing or drastic flow reduction from flattening.

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REDUCING MAINTENANCE COSTS ON UNPAVED ROADS[2]

Jerry Hinrichs is Superintendent of Highways for Ogle County, Illinois. He is the adviser to the township road commissioners who are responsible for the maintenance of 1464.5 km (910 mi) of unpaved roads that roll through farms and link small townships in the county together.

Though unpaved roads are less expensive than paved ones, their maintenance can still be a burden on the township taxpayer. Hinrichs keeps this to a minimum by using liquid calcium chloride for road stabilization and dust abatement in the summer, and ice control in the winter.

Hinrichs explains how liquid calcium chloride stabilizes road beds, saving thousands of dollars in the process: "Winter thaws, spring rains and heavy traffic–more than 100 cars per day–destroy an unpaved road surface. Road rock deteriorates and loosens, causing potholes and ruts in the road. Replacing this rock is expensive: It costs $620 per km ($1,000 per mi) to put down 25 mm (1 in) of new rock on a 6-m (20-ft) road. If we can save just 25 mm (1 in) of road rock a year, we can save township taxpayers thousands of dollars in road maintenance alone.

"Liquid calcium chloride helps us save those millimeters (inches) of road rock by keeping the road binder on the road. Without liquid calcium chloride, the road binder dries, gradually erodes with traffic, and summer winds carry it off as dust. The road rock then loosens, destroying the road surface. Liquid calcium chloride, on the other hand, has the ability to absorb moisture directly from the air, and keeps the moisture in the binder. The road surface stays slightly damp, preventing the binder from becoming airborne. It helps the rock to pack tighter, reducing rock losses and maintenance costs."

Bob Bowers, Highway Commissioner for Ogle County's Brookville township, cites a specific example where LIQUIDOW liquid calcium chloride, a product of the Dow Chemical Company, will help his township save $4,000.

"Two years ago, we spent $18,000 resurfacing 10 km (6.25 mi) of road with 100 mm (4 in) of new road rock," reports Bowers. "We applied liquid calcium chloride in the resurfacing process. If we hadn't, we'd be resurfacing that stretch again in another 2 years. With liquid calcium chloride, we don't have to resurface again for at least another 3 or 4 years.

"That 1- or 2-year extension in the resurfacing process means a saving of $4,000. That's more than enough to cover the cost of the application, and in the meantime we have a road that's safer and more comfortable to drive on because it's free of potholes and ruts."

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[2] Reprinted with special permission of Editor, Public Works, from June 1979 issue.

Bowers also states another advantage liquid calcium chloride has on road maintenance costs: "Before we began using liquid calcium chloride we had to grade roads after every rain. With grading costs at $19 per km ($30 per mi), it didn't take many rains before the grading ate up our budget. By using liquid calcium chloride, we've reduced grading to just twice a year, once before an application, and once after the first rain, just to make sure the calcium chloride penetrates the road binder."

While liquid calcium chloride helps Bowers and Hinrichs reduce their maintenance costs by holding down the road binder, it also does something else. Hinrichs explains: "By keeping the binder wet, liquid calcium chloride solves an important safety problem–dust. On an untreated road, dust creates a safety hazard by blocking driver vision. When one car is following another, the lead car creates a dust cloud that blinds the driver behind him. If the first car has to stop, the second driver isn't going to see him until he's right on top of him. The result–an accident.

"Liquid calcium chloride virtually eliminates the dust problem. Again, because of its ability to absorb moisture out of the air and retain it, liquid calcium chloride keeps the binder moist, preventing it from becoming airborne. It reduces the risk of an accident, and has the important side benefits of keeping dust off the crops in the fields and out of people's homes."

Figure 2.–Tanker above shows a typical method for applying calcium chloride to crushed rock roads.

For winter safety, Hinrichs uses liquid calcium chloride to provide motorists traction on ice-covered roads. Normally, Hinrichs applies a salt/cinder/chip mixture on the county

blacktop roads. But since the Midwest had one of its worst winters last year, road salt was in short supply. So, Hinrichs substituted liquid calcium chloride in place of salt.

"We noticed several advantages when we made the substitution," states Hinrichs. "The first was in the ease of spreading. Many times the salt and cinder mixture would clump during spreading, causing an uneven melt and difficulty getting material out of the spreader.

"With liquid calcium chloride, we just rigged up an inexpensive system that sprayed it on the cinder/chip mixture while it was in the dump truck. Each cinder and chip got a good coat of liquid calcium chloride, which prevented clumping and gave us an even melt.

"The second advantage is that liquid calcium chloride works in colder temperatures than salt. Road salt is effective down to about –7 °C (20 °F). Below that, salt tends to remain in a crystal form, and the melting process gets underway very, very slowly. Traffic scatters most of the mixture to the road side before it gets a chance to imbed.

"Liquid calcium chloride, however, is an effective deicing agent down to about –18 °C (0 °F). The melting process begins almost instantly and the cinders and chips imbed into the ice, providing traction, and by being wet the mixture doesn't scatter like our old salt/cinder/chip mixture, when in contact with the ice or snow.

"Liquid calcium chloride for road maintenance improves our road stabilization, controls dust, and melts ice, while it reduces our maintenance costs and provides safer roads," Hinrichs concludes. "All in all, we just couldn't do it without liquid calcium chloride. It's now an essential part of our maintenance program."

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PREVENTING BROKEN WINDOWS AT THE FISH LADDER, IN OROVILLE FIELD DIVISION[3]

At first glance, windows might seem out of place on a ladder, fish or otherwise. However, the term "ladder" is misleading in this instance, since the ladder in question is a concrete canal rather like a chute which leads from the river up to the Oroville fish hatchery. During the spawining season, this fish ladder is filled with water. Steelhead and salmon swim up this way to the holding tanks at the hatchery. The California Department of Water Resources built six windows into the side of the fish ladder so that interested people could watch the fish crowding past. Each window is 0.9-m wide by 0.9-m high (36-in wide by 36-in high). This gives quite a view, and they are one of the most popular features of the hatchery. School children, in particular, seem to like to watch the fish. Not all of the community shares this feeling, however, because the windows have been willfully damaged several times in the past.

The glass on the outside (viewer side) of the windows is safety type, but of an ordinary kind. When damaged, this glass costs about $36 a pane to replace. Finally, each window was fitted with a special aluminum shutter which could be snapped into place and then locked during the off season. This has prevented any further window smashing to the outside glass. Separated from the outside pane by a few millimeters (inches) of space, the inside window pane (on the water side of the ladder) is quite a different item. This pane is made of several laminations of a strong, highly-tempered, special glass. These panes have to withstand the impace of the fish and the pressure of the water. During fish spawning season, when the fish ladder is full, the windows are under water. The ladder is drained in the off season as a conservation measure. While the ladder was dry someone climbed in, walked along to the windows, and hit the glass with something heavy. The glass broke into a crazy network of cracks; in fact, "crazed" is the term used to describe this breaking. It is impossible to see through such a window.

All six windows were damaged in this way before anything could be done to prevent it. To replace the glass costs $5,000 per pane. The worst part, however, is that there is no reason to think that the windows would not be broken again once they are replaced. Every time the fish ladder is empty someone with a rock (and the hills are covered with rocks) could walk along the dry chute and hit a window. Or, they could throw the rocks from the bank.

Obviously, some sort of shutter, or other protection was needed. A shutter system, similar to the other windows, would mean cost of material and of installation. Then there would be the work of removing and reinstalling the shutters each year. Also, the inside windows are pretty well hidden from view and the shutters could be forced off without too much fear

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[3] Reprinted by special permission of the Editor, from Technical Bulletin No. 39, California Department of Water Resources.

of interruption. The maintenance crew at Oroville came up with a way of protecting the windows, safely and economically.

Figure 3.–Ordinary window.

Figure 4.–Damaged window.

Stored on property of the Field Division were a number of chain link gates, each 1.8 m (6 ft) high and various lengths. These were once used to close the ends of an old railroad tunnel

on a spur line which had been dismantled to make way for the dam. These gates should provide material enough to do something; it was either these or the aluminum shutters. Dan Trotter, General Maintenance Superintendent at Oroville, was for the most inexpensive method. The old gates were free for the taking, which is about as low cost as could be expected.

Bill Hansell, the Maintenance Supervisor, and his crew felt sure they could haul enough gates out to the fish hatchery to build some kind of protective cover for the windows. Using welding and cutting torches, the crew custom-built two end panels to go down inside the fish ladder. More gates were fitted into an overhead panel. The finished product was a chain link cage enclosing the window portion of the ladder. Figure 5 depicts a view looking down into the fish ladder through the gates which are secured to the concrete chute by metal clips bolted in place. Figure 6 depicts an end piece just ready to be clamped onto the overhead gate. These end pieces are also clipped to the concrete. Figure 7 shows the fence at the other end, and a glimpse of one of the fish windows.

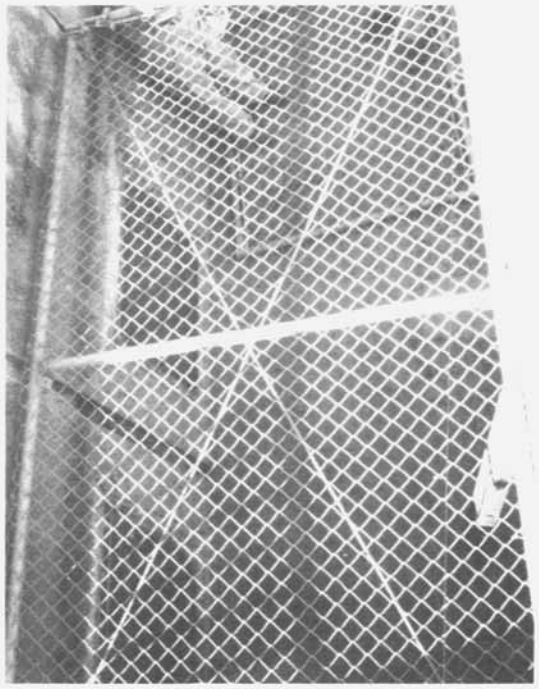

Figure 5.–Looking down into the fish ladder.

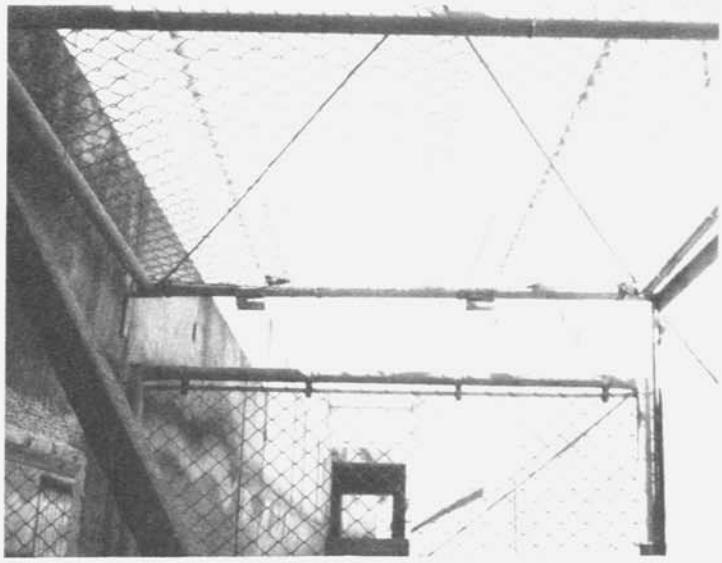

Figure 6.–End piece ready to be clamped onto the overhead gate.

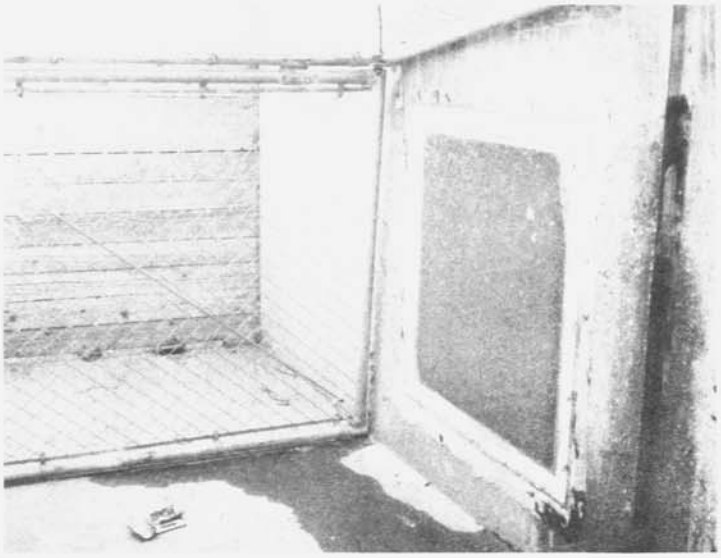

Figure 7.–Shows fence at other end, and a glimpse of one of the fish windows.

These do-it-yourself mesh barriers effectively keep out intruders, even determined ones. During the spawning season, when the fish ladder is full of water, the side screens can be drawn up and folded over so that there is no obstruction to the flow of water. The screens only cost the time of the two-man installation crew.

For additional information, please contact D. B. Trotter, General Maintenance Superintendent, Oroville Field Division, California Department of Water Resources.

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DRY MIX CEMENT IN BAGS ANCHORS DOWN BRIDGE APPROACH SLOPES[4]

Checkerboard placement of dry, premix cement in bags on the sandy soil slopes of bridge approaches is helping Hardee County, Florida, avoid the cost of wingwalls and formwork in stabilizing the slopes.

County Engineer Joe Hollingsworth said all bridges in the county have a 2 to 1 slope on approaches because the water table is near the surface throughout the area. This means bridges are more elevated than usual, especially on river spans.

To stabilize the loose sandy soil on the approach embankments, Hollingsworth "paves" them over with a dry premix cement in bags. A small mixer is used without water to mix the four parts cement and one part sand which is dumped into dry sacks.

The dry mix sacks are then placed tightly side by side across the full face of the slopes that curve around under the bridge.

The final step is the easiest: wait for rainfall to set up the mix.

This leaves a hard, cement surface between the shoulder of the approaches to the foot of the slope and also from the bottom of the bridge pile cap down into the stream.

"The technique is fast, inexpensive, and successful," said Hollingsworth. "The cost of wingwalls and abutment walls are avoided and the cost of formwork is eliminated."

The approach is constructed from fill excavated from nearby farm areas needing stock watering holes. The friendly, no-cost exchange of earthfill for watering holes has helped the county avoid the cost of locating and hauling in fill from distant sites.

The county currently is planning to replace about 75 timber bridges that have outgrown local traffic needs. An increase in industry and commerce is putting a new demand on bridge load-bearing capacities. Hollingsworth feels the new concrete spans will solve the need and provide the desired durability.

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[4] Reprinted by special permission of Editor, from recent issue of Rural and Urban Roads.

RESURFACING BRIDGE WALKWAYS WITH EPOXY[5]

Eroded by salt spray from winter traffic, the sidewalks of the Middletown-Portland Bridge in Connecticut have been completely restored by an epoxy coating. The concrete resurfacing is also expected to protect against future erosion, because the epoxy is immune from salt attack. In undertaking the job, the contractor first patched and repaired broken concrete and then sandblasted the surfaces to remove oil, grease, and paint, followed by air hosing.

For the resurfacing, "Meta Bond LV," supplied by American Metaseal Corporation, was selected. The low modulus compound was chosen for its resilence, an important consideration for application on a bridge. A portable generator powered electric mixer was used in the blending of the components. The resulting mix, poured over the walkways, was spread with long-handled squeegees to effect a coating application of 40 L/m^2 (1 gal/ft^2). After the material was dry to the touch, a binder coat was applied similarly at a rate of 1.35 L/m^2 (1 gal/30 ft^2). Sand, 20 to 40 mesh, was scattered over the surfaces to provide slip resistance and complete the job.

Figure 8.–Protective coating of epoxy material is squeegeed on bridged walkway.

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[5] Reprinted with special permission of Editor, Public Works, from June 1979 issue.

DUAL-SCALE DIAL INDICATORS ON CHECK GATES IN SAN LUIS FIELD DIVISION[6]

The implementation of SI (International System of Units)–the "metric" system of mass, distance, etc.,–in operation and maintenance of the project calls for a display of metric values as well as traditional ones. This means that dials and gages should be replaced by dual scales, or have metric information scales added to them. In the past, information pertaining to the open or closed position of aqueduct check gates was available on a computer readout from the ACC (Area Control Center) or on a "rooster tail" staff gage attached to the top of the gate. If the computer printout was not handy, the gap in the gate had to be puzzled out on the spot by seeing where a metal pointer seemed to fall on the scale. Figures 9 and 10 show a front and rear view of these scales.

Figure 9.–Front view of dual scale.

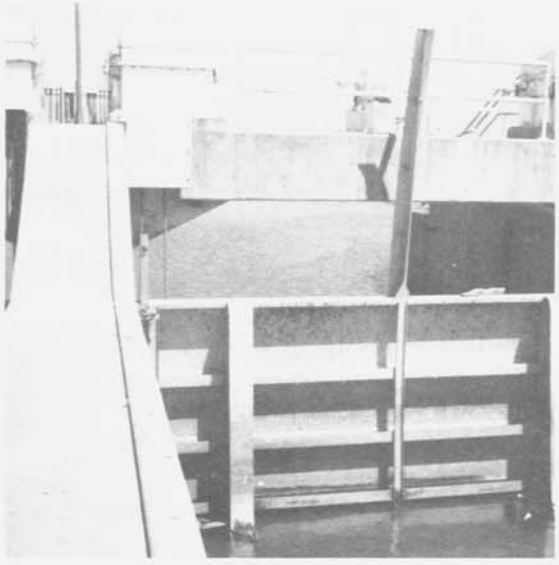

Figure 10.–Rear view of dual scale.

As shown in figure 9, the gages are easy enough to read in feet but they might be rather cluttered with metric numbers added. Now and then, the scales have been damaged by water action, or by the heavy winds which blow along the aqueduct. Replacing the scales with wider ones (for metric and feet indications) might produce a sturdier scale, but one still subject to the elements. Rather than replacing or adding to the rooster tail scale, personnel in San Luis Field Division, California Department of Water Resources, wanted a new system entirely. Bill Webb wanted something that would display both metric and standard values compactly

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[6] Reprinted by special permission of the Editor, from Technical Bulletin No. 30, California Department of Water Resources.

and easily. He discussed it with his supervisors, conferred with engineering support, and decided that an indicator with a dual face was the thing to have.

A convenient place for a dial indicator was the side of the hoist drum housing, with a geared connection to the hoist drum shaft.

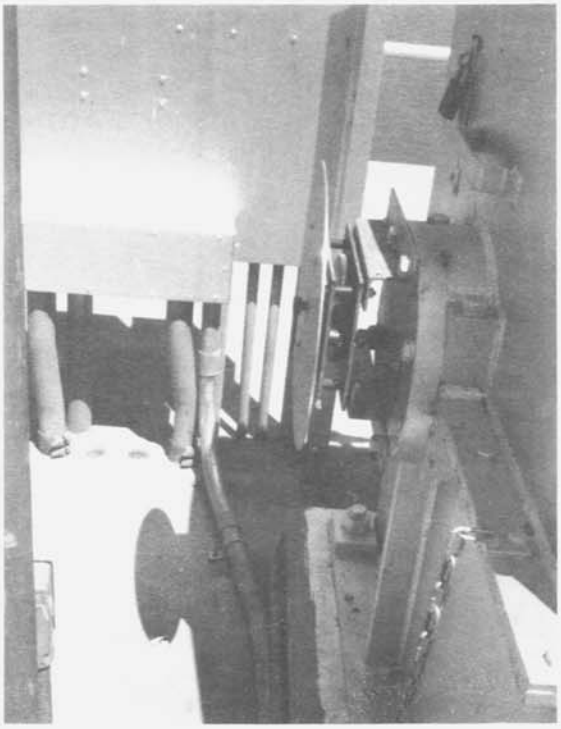

Figure 11.–Side view of indicator installation with dust cover removed.

There are four gate sites. Three of the gates use the same gearing arrangement for the hoist; the fourth has a slight difference in gate size. At all of the sites, the gear plate cover for the hoist housing had to be drilled in various places to allow for the mounting bolts of the indicator. Also, the hoist shaft had to be extended through the cover to carry one of the gears of the new indicator assembly.

The driving gear used was a small one with 22 teeth. In order to carry the indicator needle around to the end of the dial, the larger gear could only rotate once, from gate closed to gate open. Therefore, this gear would have to be chosen with care. As a part of the custom work needed, the work crew made special brass bearings. The whole group of parts then had to be assembled and bolted into a gear case, which was mounted to the hoist gear housing. A narrow, hinged, metal strip enclosed the gears to protect them and to act as a dust cover.

Making up the dial indicator plates was an additional complication. The 150-mm (6-in) indicator needle moved around in a clockwise direction, from closed to open, to parallel the action of the gate. Since the gate traveled on an arc, however, the indicated intervals at the clockwise (open) extreme of the dial would be somewhat wider apart than those down at the counterclockwise (closed) end. This variance was further complicated by the fact that there would have to be two parallel scales: metric values and conventional values.

Since the designers wanted to show 1/10th increments on both scales, setting the scales up correctly meant quite a bit of planning and effort.

An aluminum working dial scale was put in place first. Then, a communication link was set up between the gate and the operators in the ACC. Computer indications in the ACC could be correctly identified on the working dial by close work between the Operations Division and the Field Division. In this way, all of the correct points on both scales could be laid out in rough form. This working plate was then sent to O&M Drafting in Sacramento for final layout and art work. The completed layouts were sent to a firm in Ohio to be annodized (in a photographic process) onto plates, which are mounted on the gates. The graduations are so clear they almost resemble engraving, and the firm guaranteed the plates for 20 years. Gate position is easily readable in either scale.

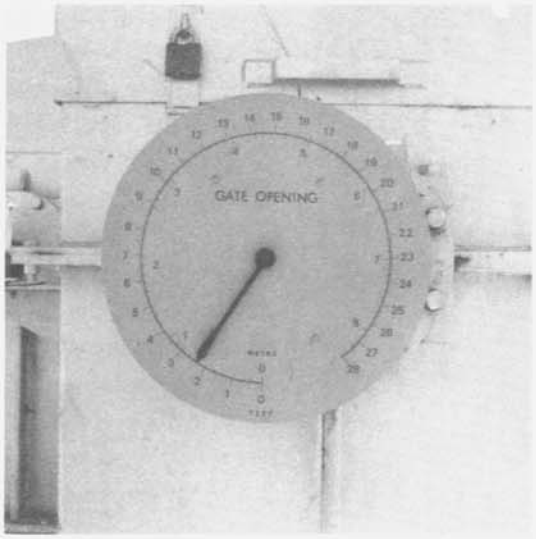

Figure 12.–Dual-scale dial indicator.

For additional information on the metric indicators, contact Ed Coble, San Luis Field Division, California Department of Water Resources.

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PUT IRRIGATION EQUIPMENT IN SHAPE FOR WINTER[7]

A few simple maintenance checks this fall and next spring may save an irrigator the cost of a service call.

According to Ed Benson, Manager of retail stores for Lindsay Manufacturing Company, most irrigators are aware of the advantages of these checks, but with busy fall schedules they often forget.

"Unfortunately, some irrigators simply shut their machines off in the fall when they're through with them and then push a button in the spring to start them up. A lot of maintenance problems could be completely eliminated if irrigators would establish a basic maintenance program," says Benson.

Some of the most important things to be done at the end of the season include removing the sand trap cap and pumping water for several minutes to flush out foreign materials from the pipeline. Also, the drain at each tower should be checked to make sure all water will drain out of the pipeline properly. It is especially important in cold climates to evacuate water from all pipes above the frost line or else pipes may freeze and burst.

Benson recommends that irrigators walk their machines without water running. "This accomplishes several things. You can check for missing gearbox seals by watching for leaking oil, check the universal joint for wear and check tires for proper inflation," he says.

There are several other things that should be considered. Bob Snoozy, Director of Marketing Services for Lindsay, says, "The gearboxes should be checked for moisture and drained. Then they should be refilled with oil so that all gears and bearings have lubricant covering them during winter months. Also, the air-breather and the exhaust pipe on a combustion-type motor should be covered with tape to keep dust out."

Other recommendations are that wire connectors, bolts, and fittings all be checked for tightness. Make sure all shields are in proper place and look over sprinkler heads for wear.

Benson suggests that irrigators who use fertilizer injector pumps should pump water through them and then diesel fuel so that they are lubricated during the off season. This helps prevent corrosion that can result from pumping nitrogen through stainless steel cylinders.

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"Many of the same maintenance checks that are critical for fall are also important for the spring. In addition, before the machines are turned on they should be inspected for any damage that livestock may have done to crop guards or wires. And the main panel should be checked carefully. If there is damage to the panel, the dealer should be called in," Benson says.

"Many other maintenance problems can be handled by the irrigator himself but he must be sure to always turn the power off before doing any work on his system," he cautioned.

"If an irrigator refers to his maintenance manual and follows a routine maintenance program, his equipment will stay in top operating condition and he'll be able to eliminate most costly down times." says Snoozy.

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EXERCISE CARE WHEN USING STRUCK TOOLS[8]

Even the professionals sometimes don't remember that getting the job done is not the paramount thing. Getting it done safely is.

The competent worker would no more use a broken hammer than he would a bent nail to start a project. But sometimes the tools he strikes with a hammer do not receive the same careful consideration.

The Hand Tools Institute, the association for American and Canadian manufacturers of quality hand tools, points out these struck tools–chisels, punches, star drills, and wedges–in many cases, do not receive the attention they should in regard to their care and selection.

Struck or hammered tools perform a variety of jobs such as cutting bricks, chipping mortar, punching holes, splitting wood, drilling masonry holes, and shearing rivets and bolts. But the correct tool is required for each job for both safety and performance.

The cold chisel is specifically designed for cutting and chipping cold metal such as steel and aluminum. The cutting edge of the cold chisel chosen should be twice the diameter of the bolt being cut. This tool should never be used on stone or concrete.

For scoring and cutting brick, block, and masonry, the brick chisel is the proper choice. Always strike this tool with a hand drilling hammer and never use a brick chisel on metal.

For drilling holes in masonry such as stone, concrete, and brick, a star drill should be utilized. The tool should be struck with a hand drilling hammer and rotated after each blow.

When driving and removing pins and rivets, alining holes in metal and marking metal, the hand punch should be selected. This struck tool should never be used on stone or concrete.

The floor chisel should be used for rough cutting and trimming of both hard and soft woods. For rough, heavy duty wood cutting, the all steel wood chisel should be used.

In every case, regardless of the tool used, safety goggles should always be worn.

Care and maintenance of these hammered tools are important considerations. The sharpness of the tool is important to its proper and safe use. When sharpening, a file and hand stone are recommended. High speed grinding can cause overheating, which may cause the tool to lose strength and durability.

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