



1974. A section of the 41/2-mile-long Dutch Flat flume as it looks now. The flume feeds water to a 26 megawatt powerhouse unit owned by the Nevada Irrigation District.



1966. All but about 10 percent of the outside wall of Dutch Flat Flume is reinforced with a concrete fillet bonded to the wall and invert.

Projects Revisited— Bonded Flume Fillets Yuba-Bear River Project

The projects - 1966. Two reinforced concrete bench flumes owned and operated by Nevada Irrigation District (Yuba-Bear River Project), Colfax, California, to provide water to power turbines for two hydroelectric plants owned by the District. Dutch Flat flume is 41/2 miles long, 14 ft. wide and 7 ft. high. Chicago Park flume is 31/2 miles long, 18 ft. wide and 10 ft. high. The 10 in. thick walls of the flumes are 60-ft.-long free-standing sections with water-stopped joints, and were poured monolithically with the 2 ft. thick concrete invert.

The problem. Shortly after Dutch Flat flume went into operation, two of the outside wall sections failed and collapsed into a canyon. The cause was attributed to a material/ construction failure. While the two sections were easily restored, design and construction engineers were concerned about other failures due to the flumes' operating conditions.

In the Dutch Flat flume the daily water flow surges from zero to 610 sec./ft., back to zero for periods of 5-6 hours, and

then to full load again. Chicago Park flume has a maximum water flow of 1060 sec./ft. and operates each day under the same surge conditions; after construction it too had suffered several wall section failures. It was believed that the aggravated daily water cycling would fatigue the reinforcing steel and result in additional concrete failures.

The solution. The engineers designed a reinforcing fillet for the outside wall consisting of a poured concrete buttress to be adhesive-bonded to the wall and invert.

Reinforcement design called for drilling 41/4 in. deep holes into the wall and invert, driving concrete bolt anchors into the invert and hookbars into the wall, pressure testing the anchors to 7000#, sandblasting the concrete and reinforcing steel, erecting wooden forms, spraying a long potlife structural epoxy on concrete and steel surfaces, and placing a 2-1/2 in. maximum slump portland cement concrete with a minimum 2 in. thick concrete cover over the steel.

Over 90 per cent of the Dutch Flat flume was reinforced in that manner in 1966, with a fillet 15 in. high on the wall and 15 in. wide on the invert. Bridge sec-

tions were not filleted because the walls there are thicker and more heavily reinforced.

The successful reinforcement of the Dutch Flat flume prompted the filleting of 5000 lin. ft. of the outside wall of Chicago Park flume in 1968, 2500 lin. ft. in 1970 and 1500 lin. ft. in 1973. The fillet in this larger flume is 20 in. high and 21 in. wide on the invert.

The outcome - 1974. The adhesive bonded concrete fillets in the Dutch Flat and Chicago Park flumes have been immersed in water and subjected to extreme surge conditions for nearly 8 years and 6 years, respectively. During those periods, according to E. G. Pretzer, Project Manager for the Nevada Irrigation District, the fillets have reinforced the outside flume walls successfully and there have been no further wall section failures.

"When the flumes are down for maintenance outages two weeks out of each year," said Mr. Pretzer, "the fillets are visually inspected for their entire length. The bond of the concrete fillet to wall and invert in both flumes still appears to be in excellent condition, and there are no signs of separation anywhere."



(Left) Reinforcement in the Chicago Park flume consists of 3/4-in. hookbars on 12-in. centers which were epoxy paste grouted.

(Right) After sandblasting, wood forms were built. A very long potlife liquid epoxy bonding agent was sprayed onto concrete and steel, and a 6-1/2 sack portland cement concrete poured.

