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Asphalt Liners in California Reservoirs Resist Loading Stress and Erosion

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For more than four decades the Metropolitan Water District of Southern California (MWDSC) has used hot-mix asphalt (HMA) to line its water reservoirs. The liners control erosion, prevent seepage and absorb loading stresses. MWDSC has recently completed two more asphalt-lined water storage reservoirs in its expanding system-a finished water reservoir at the R. A. Skinner Filtration Plant and a raw water storage reservoir at the Etiwanda Control Facility.

Skinner

The Skinner Reservoir; near the city of Murrietta Hot Springs, consists of a 340-acre-foot (111-million-gallon) finished water-finished water is drinking water-storage reservoir with floating Hypalon cover. MWDSC placed 3 inches of open-graded HMA on its sides and bottom for erosion control.

On the $22 million Skinner project, the contractor prepared the subgrade on the native Bedford Canyon formation. He removed the unsuitable material and replaced it with select clay fill. General contractor Kiewit Pacific and paving contractor Matich Corporation of Banning, California, then constructed the 3-inch-thick porous asphalt liner with 22,500 tons of HMA. According to Eric Anderson, MWDSC resident engineer, the lining will not only prevent erosion, but also will relieve back pressures and prevent upheaval of the reservoir lining when draw downs on the water level occur.

Standard Paving Equipment

Matich Corporation first paved the sloping sides of the reservoir; then the bottom. "Because the sides were designed on a 3 to 1 slope, Matich was able to place the 3-inch lift with standard paving equipment without the help of a winch," says Ben Huntsman, head of the MWDSC testing laboratory. The paver started at the top of the slope and paved to the bottom.

Compaction was accomplished with an 8-ton, 2-axle tandem roller attached to steel cables and pulled up by a winch. The rolling pattern on the slopes was up and down with no compaction percentage specified. Bottom rolling was done with a double drum roller. The 3/4-inch topsize porous mix contained 5 percent AR-4000 asphalt cement.

Etiwanda
At Etiwanda, in the city of Rancho Cucamonga, MWDSC constructed a 10-inch-thick lining composed of layers of hydraulic and porous HMA on the sides and bottom of the 490-acre-foot (146-million-gallon) raw water reservoir. Raw water is the resource used for finished drinking water. Advanco Constructors of Upland, California, was the general contractor and Best Western Paving of Walnut, California, did the paving.

Cost of the Etiwanda liner was approximately $4 million of the $22.5 million project total. It was composed of 2 inches of hydraulic asphalt, and 4 inches of porous HMA topped with 4 inches of hydraulic asphalt. Approximately 120,000 tons of HMA were placed on the project.

Subcontractor Southern California Grading, Inc. first removed an extra 5 feet of subgrade material and replaced it with select fill material. The fill was placed in 8-inch lifts and compacted to 95 percent of laboratory density (ASTM D-1557). After priming, Best Western placed the 2-inch lift of impervious, hydraulic asphalt on the reservoir's sides and bottom.

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Porous HMA
The PVC drainage system was then placed on the 2-inch liner and covered with 3/4-inch crushed drain rock. Best Western then placed a 4-inch layer of porous HMA on the drainage system and topped it with 4 inches of hydraulic asphalt placed in two lifts. Best Western placed the 4-inch-thick layer of porous HMA in one lift, rolling the mat just enough to seat the aggregate particles firmly. Excessive rolling could have caused aggregate degradation.

Resident engineer Don Slider says that the Etiwanda liner was specifically designed to withstand long-term loading stresses without cracking and to absorb short-term loadings such as wave impact. Long-term stresses are caused by settlements in the supporting subgrade or porous asphalt layer.

The porous HMA in the liner serves as a drainage layer between the two layers of impermeable hydraulic HMA. The porous mix contained 2.5 percent AR-8000 asphalt cement. See Table 1 for gradation of the porous mix.

Table 1
Gradation of Porous RMA at Etiwanda Reservoir

Sieve Size	Percent Passing
1-inch	100
3/4-inch	93-100
1/2-inch	---
3/8-inch	35-65
No.4	5-25
No.8	2-12
No.16	0-7
Asphalt cement, pct. by wt.	2.5 percent

Hydraulic HMA
Both layers of hydraulic HMA were mixed at the hot-mix facility at 280 to 300 degrees F, which matched the laboratory mixing temperature specified in the Asphalt Institute's mix design manual. The mix contained 8.3 percent asphalt cement. Table 2 shows the gradation for the hydraulic HMA.

Table 2
Aggregate Gradation of Hydraulic Asphalt at Etiwanda Reservoir

Sieve Size	Percent Passing
1/2-inch	100
3/8 inch	95-100
No.4	70-84
No.8	52-69
No.16	38-56
No.30	27-44
No.50	19-33
No.100	13-24
No.200	8-15
Asphalt cement, pct. by wt.	8.3 percent

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Gradations for both the porous liner and the hydraulic HMA match the guidelines contained in the Institute's Asphalt in Hydraulics (MS-12) manual.

MWDSC specified that the 4-inch top layer of hydraulic HMA be compacted to 96 percent of 35-blow Marshall laboratory density. After compaction, the pavement on the reservoir floor contained less than 3.1 percent voids. After placing the final 4-inch layer of hydraulic asphalt, an asphalt sealer was applied on the completed surface of the reservoir lining.

The Etiwanda project began in July 1990 and will be completed in March 1992. As part of its continuing expansion, MWDSC will begin construction of another asphalt-lined reservoir with an 150-acre-foot (49-mIllion-gallon) capacity in the near future.

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