The use of roller-compacted concrete (RCC) is not new to the Tennessee Valley Authority (TVA). In fact, TVA was one of the first to use RCC in the United States. In the mid 70s TVA used approximately 8,000 cu yd (6,116 cu m) of RCC as structural fill to support the turbine building slab at the Bellefonte Nuclear Power Plant in Scottsboro, Alabama. In 1980, Ocoee No. 2 Dam, in Ocoee, Tennessee, was the first recorded use of RCC for overtopping protection. Later Tellico Saddle Dam (1989), in Lenoir City, and Nickajack Dam (1990), in South Pittsburg, were built with RCC.

Recently TVA chose RCC for a special purpose pavement application at the Sequoyah Nuclear Power Plant near Chattanooga. A heavy-duty haul road was constructed to transport special vessels holding spent nuclear fuel rods from the reactor building to a storage area on site. A crawler transporter with tank-type treads will haul the vessels, applying a total load of 520,000 lb (235,900 kg) to the pavement with each pass.

PCA provided technical assistance to Holtec International of Marlton, New Jersey in designing the 18-in. (460-mm) RCC pavement for the haul road. RCC was selected for its high strength, durability, and ability to carry heavy loads economically. A total of 2,500 cu yd (1911 cu m) of RCC was used in the project. The contract for placing the RCC was awarded to Stein Construction of Chattanooga.
**Mix Design**

The RCC mix consisted of an aggregate blend of 27.5% ASTM C33 No. 67 stone, 27.5% No. 89 stone, and 45% sand, with a cementitious blend of 425 lb (193 kg) Type I cement and 100 lb (45 kg) of Class C fly ash. Water was added at the rate of 18 gal/cu yd (89 l/cu m). Vulcan Materials produced the RCC in a central rotary drum batch plant in Chattanooga. The mix was hauled to the site in canvas-covered dump trucks.

A mid-range water reducer (12 oz/cu yd [0.46 l/cu m]) was used to provide additional workability and act as a set retarder. This was required because of the long haul to the job site and extensive security checks at the entrance to the nuclear plant. In some cases, the time from mixing to placement was over 2 hours, but the admixture allowed adequate time for placement and compaction.

**Construction**

The concrete specification called for 6,000-psi (41.4-MPa) compressive strength in 28 days. The RCC was placed in three lifts using a conventional Barber-Green asphalt paver. A test strip was used to determine the final rolling pattern. Field quality control services during construction were provided by S&M E Inc. of Knoxville.

Control joints were not part of the pavement design, so shrinkage cracking was allowed to occur naturally. This is common in industrial applications where random cracking in the RCC will not adversely affect performance. A conventional concrete curing compound was applied after construction.

The site managers at the TVA facility were so impressed with the final product that they expanded RCC pavement construction to include several areas around other plant facilities. This included locations where placement and compaction were difficult because of obstructions.

In addition to the Sequoyah haul road, the Chattanooga area has reaped the benefits of other RCC pavement applications. The Tennessee DOT has constructed several access roads for industrial parks, and Covenant Transport Corporation recently expanded their truck terminal with RCC paving. All of these pavements have provided excellent performance since their construction.
Taming the Las Vegas Wash

Northshore Drive (Highway 147) crosses over the lower reach of the Las Vegas Wash just downstream of the dam impounding Lake Las Vegas. This section of the 12-mile (19-km) long Wash has experienced severe channel degradation over the past 20 years.

A box culvert originally constructed beneath the road was replaced by a three-span concrete bridge in 1978, when head cutting within the channel started to undermine the culvert. Since then, the channel degraded an additional 25 ft (8 m) near the bridge.

If channel degradation were left unchecked, it was estimated that a 100-year storm event would create up to 19 ft (6 m) of local scour around the intermediated in-stream bridge piers, exposing up to 10 ft (3 m) of the foundation support piling. In addition, the new vertical canyon walls supporting the end abutments had become increasingly unstable due to lateral erosion along the base of the walls.

The Central Federal Lands Highway Department developed a plan that included three grade control structures, bank protection, and an armored apron. RCC was selected as the construction material due to its durability, speed of construction, and geometric flexibility. Durability and abrasion resistance were vital because in one 1984 flood alone over 4 million cubic yards (3.1 million cu m) of sediment was estimated to have been deposited into Lake Mead from the Wash.

The three grade control structures varied from 83 to 125 ft (25.5 to 38.5 m) in width, and each allowed for 6 ft (2.5 m) of vertical grade control. Bank protection extended approximately 455 ft (140 m) from the first grade control structure upstream to beneath the bridge on both sides of the channel. Due to a poor foundation, the southernmost intermediate pier was encapsulated with a 2-ft (0.6-m) thick RCC apron.

Kiewit Western was awarded the contract to place the 32,700 cu yd (25,000 cu m) of RCC. Hopes of using on-site alluvial materials were dashed when it was found that very little coarse aggregate was available in the alluvium. Kiewit elected to import an all-in-one aggregate blend with a maximum size aggregate of 1 in. (25 mm). Typical gradation is shown in the adjacent table. The RCC was mixed on-site by a Rapid 400 electric continuous pugmill. To achieve the required 28-day compressive strength of 3,000 psi (21 MPa), 380 lb/cu yd (225 kg/cu m) of cement was added.

Due to significant base flow in the Wash, each of the grade control structures had to be built in sections. Kiewit diverted the stream to one side of the Wash and then constructed half of a structure. Then the stream was rerouted over the finished section and the remainder was constructed. Water control was a major factor during the entire project.

The RCC was delivered in dump trucks and spread in 12-in. (30-mm) layers. All the structures had uniformed faces at a slope of 1V:1H. Initial placement began at the structure nearest the bridge and the bank protection. Work then progressed in a downstream direction. RCC placement began on March 19, 2002, and was completed on June 19, 2002.

The bid price for the RCC was $ 75.70 per cubic yard ($99.00 per cu m). The entire project cost was $3,158,300.

These RCC grade control structures are some of the few that will have continuous overflows and, during flood events, be subjected to heavy bed loads. Monitoring the long-term performance of such structures will provide valuable insight for future RCC design.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch (25 mm)</td>
<td>100</td>
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<tr>
<td>3/4 inch (20 mm)</td>
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<tr>
<td>1/2 inch (12.5 mm)</td>
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<td>No. 100 (150 um)</td>
<td>10</td>
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<tr>
<td>No. 200 (75 um)</td>
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</table>
Design Manual for Small RCC Gravity Dams

A complete guide is now available on the design of RCC dams less than 50 ft (15.2 m) high. This 64-page manual contains more than 50 tables and figures detailing various design considerations. An example problem is included to illustrate the basic steps in analyzing the stability of a small RCC dam. Separate chapters cover:

- preliminary site investigation
- foundation considerations
- design loads
- stability analysis
- spillway provisions
- special design issues and details
- facing systems
- RCC mixture proportioning

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