South African Fly Ash Used to Help Build the Continent's Longest Suspension Bridge

By Mark Hunter

Mozambique sits astride the Indian Ocean and shares a southern border with South Africa. This developing country is now nearing completion of a major infrastructure project—the construction of a bridge linking the capital, Maputo, with the city of Katembe—that is expected to benefit the region by reducing travel time between the two countries and boosting economic opportunities.

The Maputo-Katembe bridge will reduce travel time and boost trade opportunities in Southeast Africa.
SOURCE: South African Coal Ash Association

The project is one of the major capital investment initiatives undertaken by the Government of Mozambique, which appointed the China Road and Bridge Corporation as the main contractor and GAUFF Engineering as consultant. The bridge, built over the Bay of Maputo, has an open span of some 680 meters and a clearance height of 60 meters to accommodate the bay's very active shipping lane. Providing a connecting route that will trim road-based transportation times to South Africa—from which Mozambique imports many of its staples—by at least three hours, the bridge is expected to open new investment options in the region.

With sustainability a critical consideration in the bridge's construction, balancing social, environmental, and economic factors required innovative thinking. This led to the choice of substituting at least 35% of the cement in the concrete with South African fly ash. The reduced emissions associated with the use of the fly ash at 2 kg CO_2 e/ton—compared to cement at 840 kg CO_2 e/ton—yielded substantial environmental benefits.

Construction

The bridge's main cables are affixed to two massive "anchor" blocks on the north and south side of the bay situated 260 meters and 284 meters from the main pylons, respectively. Two circular shafts 50 meters deep with a diameter of 50 meters each have been constructed to house the concrete and sand-filled anchor blocks, which support the entire main span of the bridge. For perspective, the south bank anchor block weighs 177,000 tons. This is a concrete block the size of a football field 15 meters high.

Bridge builders employed three different methods of construction. The north approach uses the balanced cantilever method, one of the most technically challenging bridge construction technologies, which is further complicated by the fact that it is on a curve. The main span of the suspension bridge, the south approach, consists of post-tensioned T-beams of 30 and 45 meters, respectively. The north bank pylon is 135 meters high, and the south bank pylon stands at 136 meters.

- The north approach balanced cantilever bridge consists of post-tensioned reinforced concrete box girders and will be 1097 meters in length, with the largest span being 119 meters.
- The southern approach precast T-beam bridge is 1234 meters long. A total of 283 concrete piles with diameters

of between 1.5 and 2 meters, and 55 meters in length, were constructed on the south bank; 138 piles line the north bank.
- The two pylon pile caps are supported by 24 piles with a diameter of 2.2 meters each sunk to an average depth of 110 meters.

The main cable is composed of 91 galvanized high-strength 5-millimeter steel wires, resulting in a total cable diameter of half a meter, two of which will run parallel over the pylons from anchor to anchor. The total length of the wires is a staggering 10,899 kilometers.

Concrete Mixture

Two computerized batching plants are dedicated to the construction of the Maputo Bridge. One plant is situated in Maputo and the other is in Katembe. Both plants are within 2 kilometers of the site. The capacity of each plant is 120 m^3 per hour.

Fly ash supplied by Ulula Ash is transported from South Africa to Cemento Maputo in Matola approximately 15 kilometers away and is stored in large silos at the respective batch plants. Aggregates from four suppliers are stockpiled on site to ensure the ability to produce concrete 24 hours a day, 7 days a week. The contractor has 12 approved mixture designs.

The siliceous fly ash used complies with the SANS specification and provides the following benefits:
- Increased later-age strength—for example, at 90 days
- Reduced rate of chloride diffusion through the concrete
- Prevention or retardation of alkali-silica reaction
- Reduction in rate of heat generation by up to 20%
- Reduced shrinkage due to lower water demand
- Significant reduction in the risk of thermal cracking
- Improved sulphate resistance.

Physical testing is being performed in the on-site laboratory to confirm the results received.

High workability of the concrete was one of the main design parameters. Constructing piles 110 meters deep, and pumping the concrete to a height of 140 meters, meant that a very fluid concrete was required.

Project Participants

- The Government of Mozambique, represented by Empresa de Desenvolvimento de Maputo Sul.
- GAUFF GmbH & Co. Engineering KG, Nuremberg, Germany/ Maputo, Mozambique.
- China Road and Bridge Corporation, Beijing, China. ❖

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