Use Of A Rock Ramp For Grade Control – Dueñas Bridge Case

Julio M. Kuroiwa, Alfredo J. Mansen and Edgar Rodriguez
Mansen Kuroiwa Ings SCA, Lima, PERU

Abstract

Lima, with a population of 8 million inhabitants is crossed by the Rimac River. The Rimac River descends from the Andes Mountains and flows West to the Pacific Ocean with an average slope of four percent. It separates the Northern Cone (Northern Section) from Downtown and the southern portion of the city. When Lima started an explosive expansion in the late 50s, people began occupying the northern section, and bridges were built to allow communication between the new settlements and the rest of the city.

The Dueñas Bridge was as a two – opening bridge with two abutments and a central pier. Since the construction of the bridge in 1966, major changes have taken place in the river. At first, most of the flow concentrated near the left bank, incising the bed. The river continued passing through the left opening and the central pier acted as an abutment thereafter. The bed was undermined severely and remedial works took place in 1978. A reinforced concrete drop was built with a blanket of cyclopean concrete placed downstream of the drop. The structure failed, leaving concrete “spurs” that directed the flow towards the right bank where vortices formed. In October 2001, the river had lowered its base level in 8 m (26.67 ft) and it was 10 m (32.8 ft) wide. The current right bank had been undermined, exposing the soil underneath the pier and compromising the stability of the central pier. This called the attention of the engineers of INVERMET (A City - owned infrastructure investment department). The bridge was declared in emergency in October 2001 and remedial works had to take place before the rainy season started in December 2001.

The authors of this paper were invited along with a group of colleagues to design an emergency solution to protect the bridge against the 2001 -2002 floods. The task was accepted by the authors who proposed the construction of a rock ramp with a broken slope and a rock toe at the end. Inclusion of geotextiles was initially considered, but it was discarded during the construction process because the contractors were unable to divert the flow and keep the construction schedule on time. In addition, removal of old concrete structures was included as part of the works that were carried out at the site. The paper summarizes the evolution of the morphology of the Rimac River since the 1950s until the present time, the solution that was designed and constructed until the end of November, and the performance of the ramp. With the rainy season almost finished, it can be said that the rock ramp performed as expected and that the structure successfully protected the river bed in the vicinity of the bridge against further undermining.