

# Innovative Geosynthetic Saves 100 -Year-Old Panama Canal

Tom Stephens<sup>1</sup>

<sup>1</sup>TenCate Geosynthetics Americas, 365 South Holland Drive, Pendergrass, Ga.:

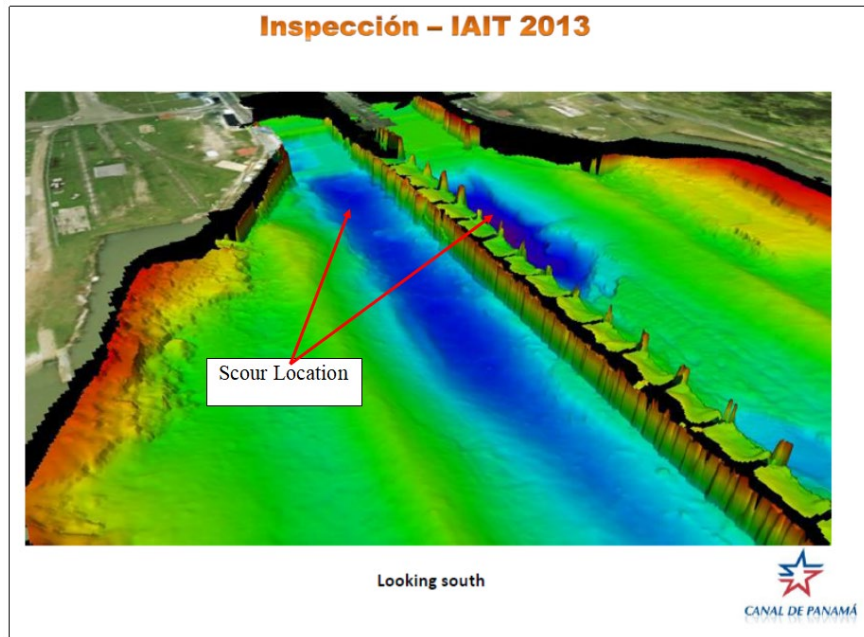
[t.stephens@tencategeo.com](mailto:t.stephens@tencategeo.com)

## Abstract

The Panama Canal opened for business 105 years ago. It was hailed as the eighth wonder of the world and an engineering marvel of that time. Since 1914, the originally three sets of 33m wide x 300m long x 14m deep dual parallel lane locks have been in continual operation. However, ships have become larger and the tugs to maneuver them in and out of the locks have become more powerful. The latest version of Panama Canal tug is a 28m long and is powered by twin 4,400 HP electric engines with azimuthal propulsion. With this increase ship size and in tug power, prop wash combined with the continual increased velocity of the flow of water thru the locks of the canal has experienced erosion along the dividing wall foundation and in front of and underneath the 1.0m thick approach slab.

Since 1979 the canal been administered and operated by the Autoridad del Canal de Panama (ACP). The ACP's Engineering and Maintenance Division has insured that the canal has been continually operated under safe conditions with modern upgrades and expansions. In December 2013 the ACP Engineering and Maintenance team conducted the annual comprehensive sonar investigation of the entrance and exit of each chamber of all three sets of locks. It was discovered that there were numerous areas of erosion scour that were occurring at the leading edge and under the approach slabs, along the dividing wall foundations, and around the base of several wing walls. This erosion was significantly more advanced and extensive than had been observed in previous years. The worst areas of erosion scour which were occurring at the Atlantic entrance to the Gatun Locks approach slab and dividing wall. Figures 1 details the extent of the scour erosion. These areas were monitored every month during 2014. In early 2015 ACP determined that the scour areas were continuing to progress, and several areas were becoming critical to the extent that a catastrophic collapse could result.

This case history will detail the use of innovative geosynthetic technology and marine construction techniques by the ACPs Engineering and Maintenance Division to keep the canal operating 24 hours a day without any unscheduled interruptions to tonnage of operations. The case history will detail the geosynthetics science of testing and design that enabled this process to successfully solve the erosion problems underneath and around the canal locks in water depths to -20 meters by using 90-ton (50m<sup>3</sup>) sand filled 200 kN/m woven geotextile geobags and 400 kN/m geogrid materials. In addition, the case history will detail how the repairs were performed without any unscheduled interruption of the canal's operation.



**Figure 1. Scour Erosion Discovered in 2013 at the Gatun Locks Atlantic Entrance**



**Figure 2. 90 Ton Geobag Lifted With 400 kN/m Geogrid**



**Figure 2. 90 Ton Geobag Prepared to be Placed in -20.0m of Water at Gatun Locks**

## **CONCLUSION**

This innovative geosynthetic geogrid and geobag technology combined with the installation methodology are credited in allowing the ACP's Engineering and Maintenance Division to be able to respond rapidly to a serious threat to the +100-year-old Panama Canal Locks that if not addressed in a timely fashion could have caused serious consequences or catastrophic damage resulting in the loss of millions of dollars of revenue and cost millions in construction cost to the ACP. In addition, the innovative geosynthetic solution allowed for all the required repairs and erosion protection to take place during scheduled maintenance windows without any loss of the canal's income from operations.

## **ACKNOWLEDGEMENT**

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