

## 6ª CONFERENCIA INTERNACIONAL GEOTECNIA DE DUCTOS

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### WORKS PERFORMED AS MITIGATION MEASURES AFTER HEAVY RAINFALLS

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#### RESUMEN

In February 2023 record rains fell over the coastline of São Paulo State, Brazil. Between the evening of February 18<sup>th</sup>, a Saturday, and the following morning, 683 mm fell over Bertioga and 627 mm over São Sebastião. These precipitations were exceptional and records for the cities, resulting in several casualties.

The city of São Sebastião lays along the Sea Ridge, a mountainous region along the coastline whose hillsides are crossed by the Petrobras pipeline OSBAT, a 120 km long pipeline stretching along the coast in São Paulo. Approximately 50 km of this length cross the Sea Ridge and are, therefore, subject to geohazards such as landslides or debris flows.

Following those heavy rains and their grave consequences, an inspection program was carried out, in which the whole hilly lengths of OSBAT along the Sea Ridge were inspected on foot by our geotechnical crew. As a result, 52 geohazard occurrences were detected and given correspondent degrees of risk, ranging from low risk I to high risk VI, according to our classification.

Among the 52 points, 34 were classified as low-risk, 10 as moderate and 8 as high-risk. Among those last 8, 5 were considered dangerous enough as to force pipe operation halt.

The following geohazards occurred in those five spots: in OSBAT km 36+150: debris flow; km 37+000: debris flow; 37+500: landslide upstream and downstream of the pipeline; km 41+100: debris flow; km 41+700: debris flow, downstream landslide, toppling. Operation was interrupted for 3 weeks, until inertial IPI survey was carried out and no significant deformation was found.

Emergency measures had to be taken on the critical five spots to reestablish safety, especially debris removal, unclogging of existing drainage systems, localization of pipes, SPT soil testing and topography, Lidar and convencional, besides the application of steel plates and concrete slab for pipe protection. The other high-risk and the moderate-risk points were treated more or less in the same way, in a lesser scale, as required for each point.

Immediately after those emergency measures, further bigger-scale works have begun, consisting of: in km 36+150, a big drainage structure, including a water ladder up to the roadway downstream. in km 37+500, soil nailing a downstream slope and drainage, in 41+700: soil nailing of a slope, high-resistance steel mesh for a rock slope, drainage.