The slope pipeline engineering of Tanzania Mnazi Bay Underwater landslides analysis and engineering prevention advice

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Extended Abstract:

1.1 Project profile

Tanzania Mnazi bay pipeline is the total package construction by China National Petroleum Corporation, but has not yet been put into production operation, laying in parallel to the coast beaches. The width of coastal shore beach is one hundred meters, namely pipe nearly hundred metres away from the sea level. Pipeline buried depth is 900 mm, and tube diameter is 400 mm. Beach is flat and tilt towards the ocean, grade 3-5 degrees. Pipe routing via beach happened overall subsidence (slip) 2015/1/13 14:21:55, forming a bay between pipeline and sea water. Now the closest distance between the pipe and the sea is 4.5 meters, the highest water level away pipeline is the closest one meter, which is a serious threat to the security.

The analysis is according to the survey data (CPE Project No. TAN-1000-GE-RT-0005) , geological exploration data nearby submarine and pipeline exploration data. Drilling data show: the adjacent borehole histogram of MBZ1、MBD1、MBD2 are missing the third mucky silty clay layer Q4al+m,until the third muddy clay layer Q4al+m of MBZ2 exposed again in the stratigraphic column (CPE Project No. Tan-1000-GE-RT-0005, Boreholes Distribution plan SN 1/5, and Borehole Logs Sheet 1 of 19, Sheet 3 of 19, Sheet 4 of 19, Sheet 5 of 19).So, we reach a decision that the ③ layer Q4al+m easy to liquefaction is missing on the analysis region, which is the result of this layer liquefaction flow and the slump.

1.2 Landslide stability analysis

Morgenstern-Price limit equilibrium method are adopted to analytical calculate marginal stability.

From the analysis of area plan(figure 1) and the exploration data, we judge the location of landslide shear outlet should be in front of leading edge about 250m, and slip mass volume is $200*220*250=11*106m^3$. Calculation parameters used exploration data, parameter and contour, part contour has encrypted by the interpolation method.
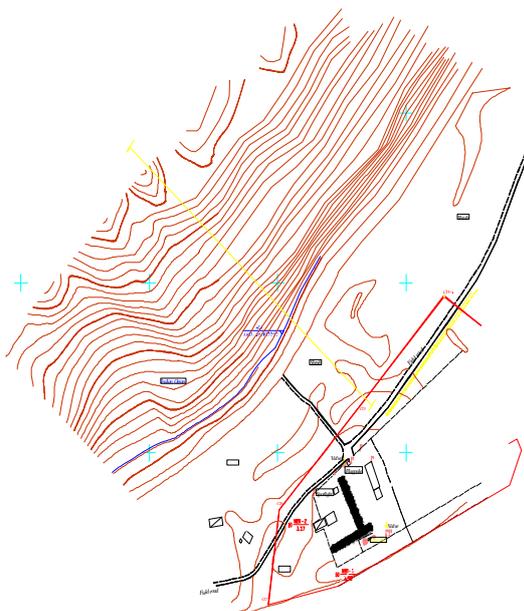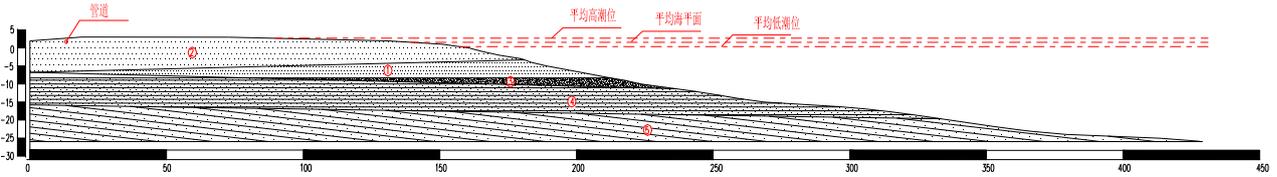

Figure 1 Tanzania pipeline landslide plan

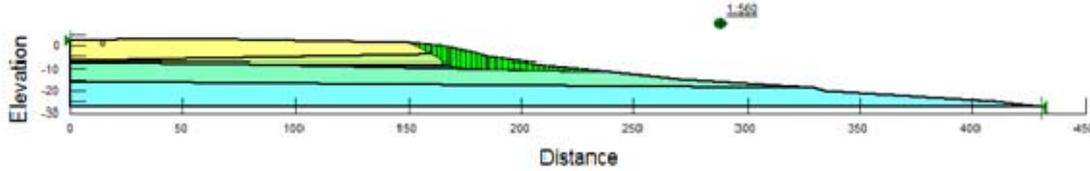Figure 2 Tanzania pipeline landslide profile

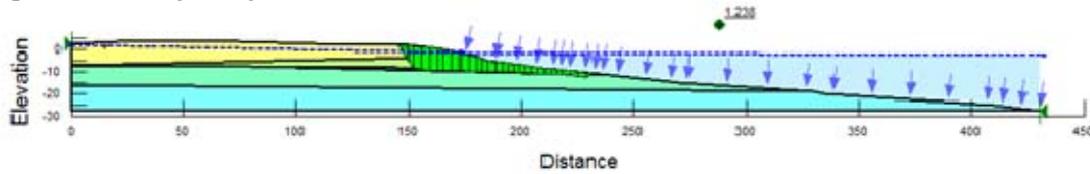Figure 3 Stability analysis without the action of water

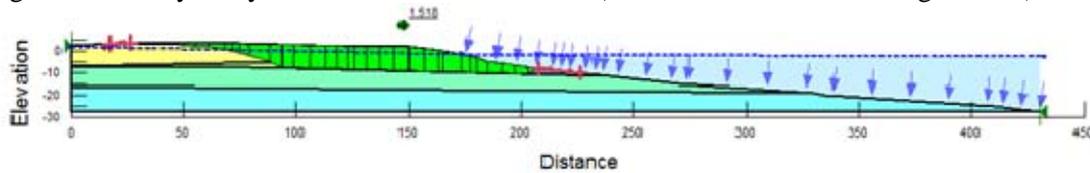Figure 4 Stability analysis under the action of water(Automatic search of sliding surface)

Figure 5 Stability analysis under the action of water(Artificial fixed shear location)

1.3 Protective measures

As above analysis conclusion, the gradual slope destroys after the landslide rear wall instability should be the results of shore existing steep slope, which is beyond the rear scope of the underwater landslides. Since 2014, slope has been towed back. Due to the lack of liquefied layer, subsequent steep slope destruction is mainly abrasion damage. Therefore, slope protection and slope reinforcement should be able to achieve the purpose of protecting pipe.

Protection scheme as follows:

About the scarp protection, sandbags are used for scour prevention, and hollow block for surface wave and flow. The top of the protective layer form at least 3 meters width, in order to make sure the enough safety range, and fill constantly after as the subsidence. However, because there is no connection block stone between sand in this kind of method, which is easily damaged in the spring tide or wave, subsidence. If funds allow, concrete slope protection is the best for the long-term safety.

Note: it is recommended that grouting depth is about 15 meters, the depth of quincuncial piles should be deeper than the third weak sliding surface (for details see section and stability calculation chart). Construction should be from both sides of the slope to the middle of the slope.
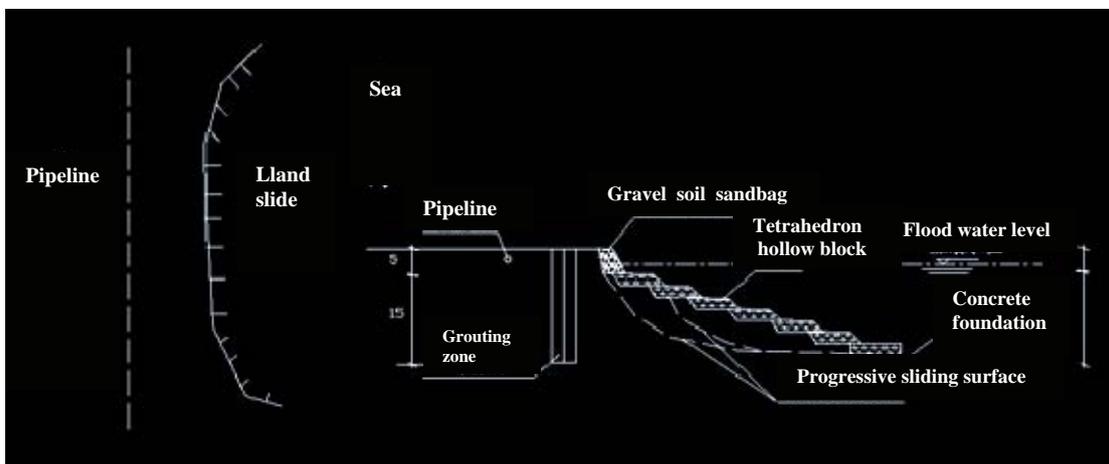
Slope protection scheme(In order to facilitate the identification, slope angle is local amplified, which does not represent the real angle. Specific size is in accordance with the results of practical exploration)

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