STUDY OF THE INFLUENCE OF CONSTRUCTION SEQUENCE ON SLOPE RECTIFICATION PROJECTS

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Rain–induced slope failures in residual soil slopes are a common geotechnical hazard in most tropical countries like Sri Lanka. To reduce the risk of failure in slopes with low safety margins, or to rectify the slopes that have already failed, a wide range of risk mitigation measures are available. However, the application of such mitigation measures on a sloped body must be carefully planned, ensuring a sufficient safety margin exist, during the period of construction.

Under this study, the importance of following a proper construction sequence for stability enhancement was studied using two rectification projects; one at Ginigathhena in Colombo – Hatton road and the other at Badulusirigama near Uva Wellassa University.

The slope failure at Ginigathhena occurred with a toe excavation for the widening of the road, without realizing that it was a site of an ancient landslide. The rectification of the slope with the allowance for road widening was done later with; surface drainage, sub-surface drainage, and soil nailing. A top-down approach was adopted for the excavation. Initially, the water level in a flat waterlogged area at the upper part of the slope was lowered by surface drains and trench drains. The excavation of the slope was done incrementally from the top to down while installing soil nailing to support the excavation and installing the sub-horizontal drains to lower the groundwater table to economize the soil nailing design.

The Badulusirigama project involved only surface and subsurface drainage without any change in the slope geometry. The failure mass consisted of three fully specified failure surfaces. During the rectification, the sub-horizontal drains were installed in a bottom-up approach.

In this study, the importance of a correct construction sequence for stability enhancement was analysed using Spencer's method. The analysis was done using GeoStudio 2018 software packages; SLOPE/ W and SEEP/ W.

During the analysis for the Ginigathhena project, the stability condition of the failed slope before construction was evaluated under two case scenarios: with and without rainfall effect. The FoS of the slope without rainfall effect was found to be 1.105, but it has reduced to 0.947 during a rainfall event. So, before moving into more complex and time-consuming construction steps, the slope had to be stabilized to achieve a sufficient safety margin for the construction. As a result, the groundwater table lowering using upper slope surface drainage improvement and temporary sub drains were introduced to the slope. With the lowering of the groundwater table, the FoS has increased to 1.101, providing a safe environment to continue the further construction steps. The analysis indicated a FoS value lesser than one with the toe excavation. Therefore the excavation had to be conducted in a top-down sequence. But the initial excavation depth had to be minimized to a value of 6.8m and further excavation downwards had to be done along with soil nailing to support the unsupported excavation.

For the Badulusirigama Slope rectification, the installation of sub-surface drains could be done in top-down, bottom-up, or intermediate sequences. But, the intermediate sequence was found to be most appropriate for the stability enhancement of all three failure surfaces promptly.

Keywords: Slope stability, Construction Sequence, Slope rectification

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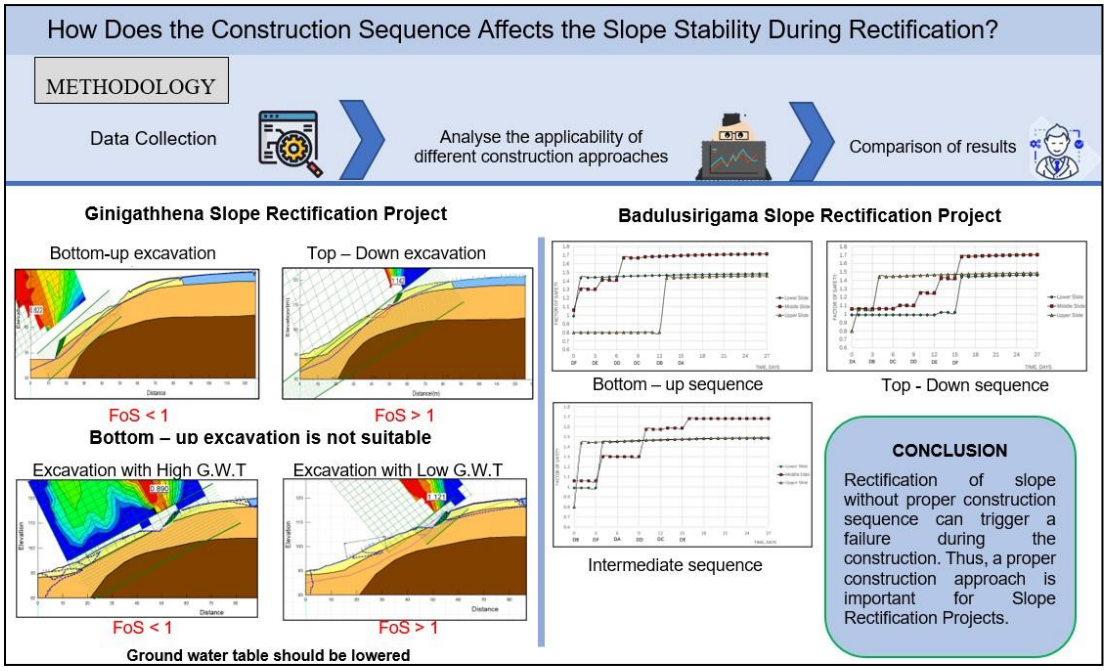
How Does the Construction Sequence Affects the Slope Stability During Rectification?
METHODOLOGY
Data Collection
Analyse the applicability of different construction approaches
Comparison of results
Ginigathhena Slope Rectification Project
Bottom-up excavation
Top – Down excavation
FoS < 1
FoS > 1
Bottom – up excavation is not suitable
Excavation with High G.W.T
Excavation with Low G.W.T
FoS < 1
FoS > 1
Ground water table should be lowered
Badulusirigama Slope Rectification Project
Bottom – up sequence
Top - Down sequence
Intermediate sequence
CONCLUSION
Rectification of slope without proper construction sequence can trigger a failure during the construction. Thus, a proper construction approach is important for Slope Rectification Projects.