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Effect of Reinforcement on Multi-Tiered Fly Ash Wall

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Abstract

Fly ash is a by-product formed by the burning of coal in thermal power plants. In India, the generation of fly ash in the year 2014 to 2015 was 184.14 million tons. However, only 55.69% of the total fly ash was utilized. The disposal of fly ash is a major environmental concern. The present study aims at utilizing fly ash as backfill for the wall in a tiered configuration. A multi-tiered wall is a soil wall constructed in tiered configuration by providing offset at different elevations of the wall. The behaviour of multi-tiered wall is essentially affected by the critical offset distance which can be defined as the length of the offset beyond which the tiers of the multi-tiered fly ash wall start behaving as individual walls and there is limited interaction between the two tiers. There are very few studies on multi-tiered walls investigated by using laboratory model tests. Also, the studies of the behaviour of tiered walls utilizing industrial waste such as fly ash are limited. In the present study, laboratory model tests were conducted utilizing fly ash as backfill material and jute geotextile as reinforcement under strip loading. The two-tiered wall was modelled and the offset distance was varied as 0, 0.2L, 0.4L and 0.6L, where L is defined as the height of lower tier. The length of reinforcement was taken as 0.7H where H is the total height of the wall. Unreinforced and reinforced models were tested to determine critical offset distance, the effect of offset distance and reinforcement on different parameters governing the design of the tiered wall. From the observed failure pattern of model tests, it was found that inclusion of reinforcement increases the critical offset distance. The critical offset distance was found to be 0.4 times the height of lower tier for the unreinforced model and 0.6 times the height of lower tier for the reinforced model. The inclusion of reinforcement also reduces the horizontal wall facia displacement. Decrease in wall facia displacement was also observed with increase in the offset distance.

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Keywords: Tiered wall; Fly ash; Geosynthetic reinforced wall; Critical Offset Distance; Jute Geotextile

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1. Introduction

"A tiered wall is a transitional structure between a single wall and slope that can reduce construction costs and increase system stability compared with a single wall"[1]. Constructing a tall wall in tiered arrangement with smaller heights provides a better control on construction and reduces the stress acting on facing elements. If the wall has a tiered configuration, the stresses reduce at lower level and wall with more height can be constructed. Fig. 1 shows the line sketch of the multi-tiered wall.

Nomenclature

L	upper tier height
U	lower tier height
H	total height of the wall
D	offset distance

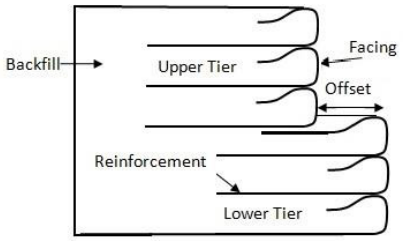

Fig. 1. Two-Tiered Fly Ash Wall.

Several researchers have carried investigation on reinforced wall [2], [3]. Investigations on multi-tiered reinforced wall have been done using numerical methods [4], field monitoring [5], [6] and laboratory model tests [1], [7]. Leshchinsky and Han [4] have used two independent analyses: limit equilibrium analysis and continuum mechanics analysis to carry out a parametric study on the multi-tiered wall. The approach used does not distinguish between reinforced walls and slopes but rather provide a unified method that is consistent with slope stability design as well as retaining earth wall design in geotechnical practice. In Full-scale load testing by Kim and Yoo [8] on two-tiered walls, only surcharge is varied without any variation on the offset distance or number of tiers. Few studies [5], [6] have been made by field monitoring due to which the performance was studied within serviceability limit. There is still need to quantify the effects of various parameters on multi-tiered reinforced wall for a better understanding of its behavior. The studies available also discusses the effect of offset distance on reinforcement strain [5], [9], [8]. However, very few studies are available focusing on the effect of reinforcement.

Fly ash is an industrial waste formed by the combustion of pulverized coal. In India, 184.14 million tons of fly ash was generated in the year 2014 to 2015 out of which only 55.69% was utilized. Disposal of Industrial waste is one of the major problems. This problem can be solved by utilizing fly ash in large quantities in geotechnical engineering construction such as a fill material in reinforced walls and slopes. A large quantity of fly ash can be utilized in practices such as backfill material for reinforced retaining wall. Many researchers ([10], [11], [12], [13], [14], [15]) have studied the engineering properties of fly ash and found that fly ash acts as a good geotechnical engineering material. Investigation to understand the feasibility of fly ash as a backfill material have been made by Lal and Mandal [16]. However, no study has utilized fly ash as fill material in the multi-tiered retaining wall.