

Finite Element Prediction of Progressively Formed Conical Stockpiles

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Abstract: Conical piles of granular solids can be found in many industrial sites. These piles are usually progressively formed by depositing from above. A classic question concerning such simple piles is the observation that the pressure distribution beneath the pile shows a marked local minimum beneath the apex which is counter-intuitive as this should be the location expected to have the maximum pressure. Numerous experimental, analytical and computational studies have been conducted to investigate this classical problem over the last few decades, but a comprehensive understanding of the problem remains elusive. A number of recent finite element simulations of the pile have considered the effects of construction history, plasticity and stress-dependence of modulus of the granular solids. Whilst a pressure dip beneath the apex has been predicted, significant uncertainties remain about the effects of these factors on the pressure dip and their interaction.

This paper presents the finite element modelling of a conical stockpile using Abaqus. The effect of construction history was realized by simulating the progressive formation of the conical pile. This was achieved by discretising the final geometry of the stockpile into multiple conical layers and then activating each layer sequentially. The effects of the elastic and plastic parameters were explored. The results show that a pressure dip may or may not be predicted depending on the constitutive model and the values for the model parameters. The study also shows that modelling the conical pile in one single step does not produce the pressure dip. It further shows that the central pressure dip is predicted using a relatively small number of layers and the magnitude of the dip is not sensitive to increasing number of layers, which is in contrast with one previous study.

Keywords: Sandpile, Stockpile, Stress distribution, Pressure dip, Pressure dependent modulus, Progressive layering, Incremental construction.

1. Introduction

The behaviour of granular solids has attracted much attention of researchers from many communities such as Applied Mechanics, Geotechnical Engineering, Chemical Engineering, Materials Handling, Agricultural Engineering and Geophysics. The storage and handling of granular materials is essential to many industries (Nedderman, 1992). Where the material is held