Influence of large-scale asperities on the stability of concrete dams

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Abstract

For concrete dams founded on rock, there are only a few options in the common analysis methods to account for large-scale asperities. However, previous research alludes that they have a significant impact on the behaviour of interfaces under shear. This study investigates the behaviour of concrete dam scale models with varying interface geometries, under a realistic set of eccentric loads. The outcome of the scale model tests shows that not only the capacity of the scale models was significantly impacted by the asperities, but also the type of failure in the scale models.

Keywords: Concrete dams, scale model tests, finite element analysis, digital image correlation

1 Introduction

In accordance with guidelines and standards [1-6], concrete dams are often assessed by analytical methods of calculation. Examples of such methods are the limit equilibrium method or shear friction method for the sliding failure mode, and calculation of the resultant location for the overturning of the dam body. One of the common idealizations these methods require is that considerations regarding displacement are to be neglected [2]. Such an idealization leads to potentially beneficial effects from large-scale asperities, e.g. interlocking between the dam body and foundation to be neglected in the assessment. However, it has been reported that large-scale asperities have a key part in the behaviour of sheared interfaces [7-11]. Also, the location of the large-scale asperity along the interface has a significant influence on the shear capacity of a interface under eccentric loading [12].

When many existing dams were built, the requirements of safety were generally lower [13]. Therefore, the problem that may arise is that the assessment of existing concrete dams may indicate towards insufficient stability. Bearing this in mind, questions regarding the suitability of these analytical methods, for stability assessment arises. These methods may more accurately estimate a concrete dam capacity if, for example, they are further adjusted to account for large variations in the rock-concrete interface. However, before any adjustments are made, a better understanding of these geometrical features of the rock-concrete interface is necessary.

Using experimental testing of four different scale models with varying rock-concrete interface geometries, this study attempted to investigate the effect of large-scale asperities in the rock-concrete interface on the behavior of concrete dams under a realistic set of loads (hydrostatic pressure, ice load, and uplift pressure). The prepared scale models were based on the existing Kalhovd dam, whose recent assessment led to the conclusion that the dam had insufficient stability for the requirement imposed by Norwegian standards [5].