Introduction

The purpose of this report is to provide guidance for evaluation of the potential for erosion caused by seepage through levees and levee foundations. This report addresses the phenomena associated with seepage-induced levee failure modes and provides clarity on the terminology used in literature and in practice. Empirical and rational methods for evaluating seepage are described and discussed. The theory and design procedures associated with both vertical and non-vertical flow are discussed in detail. In addition, guidance is provided with regard to the use of finite element computer software to perform seepage analyses.

Seepage through Soil

Darcy's Law

Steady state seepage through soils is governed by Darcy's Law. The expression for Darcy's Law in three dimensions is as follows

$$Q = k \cdot i \cdot A \qquad \text{(Eq. 1)}$$

where:

Q = seepage quantity, ft^3/sec,
k = hydraulic conductivity or permeability, ft/sec,
i = hydraulic gradient (see Figure 1) = head drop/flow distance, ft/ft, and
A = gross flow area, including the area encompassed by voids and solid particles, ft^2.

For flow in two dimensions, the expression for Darcy's Law is as follows

$$q = k \cdot i \cdot a \qquad \text{(Eq. 2)}$$

where:

q = seepage quantity for one foot width of flow channel, measured perpendicular to the plane in which flow occurs, $ft^3/sec/ft$,
k = hydraulic conductivity or permeability, ft/sec,
i = hydraulic gradient (see Figure 1) = head drop/flow distance, ft/ft, and
a = gross area of flow for a one foot width flow channel, ft^2/ft.