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The Role of Inclined Clay Core on the Shell Seepage Rate

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Abstract

Seepage analysis is a significant issue for Civil Engineering projects including dams, canals and reservoirs. If it is not properly addressed, it will result in the failure and finally instability of earth dams. This article studies the water seepage from the shell of San Fernando Earth Dam in Los Angeles, the U.S., focusing on the changes in Clay Core angle by Geo-Studio software. The results of such changes have been compared for three conditions of vertical clay core, and clay cores with 20° and 40° angles from the vertical line. The comparison of seepage rate in these three conditions reveals that vertical and 20° states are more convergent than 40° state and seepage rate is higher for the construction of clay core with a 40° angle, despite some executive advantages it may have. Moreover, the fluctuation of seepage rate at the entry and exit sections of the core is higher than the seepage path.

Keywords: Earth Dam, Seepage Rate Analysis, Vertical and Sloped Clay Core, Flow Lines and Isopotential Lines.

1. INTRODUCTION

By all measures to prevent the destruction of dams and their safety procedures, but a large number of earth dams have been destroyed and caused great financial losses and fatalities. According to investigations on the causes of failure of earth dams in the last hundred years, due to seepage and internal erosion has about 25% of the failure causes. Seepage in the earth dam can cause damage in two ways: internal erosion, starting progressive erosion from the downstream and body [1].

Sinker Greek and Titan dams in 1943 and 1976, which were built in America, Idaho, due to internal corrosion caused from seepage were destroyed. North Ridge earth dam in Canada, damaged in 1953 due to progressive corrosion and lower levels of is loss [2]. It can be concluded that the intense and concentrated water seepage is because of poor construction and lack of control in soil compaction procedure and consequently increasing permeability of layers. Two researchers named Xiang Song Li and Haiyan Ming have examined effects of water flow on the stability of the whole earth dams with a clay core in San Fernando, Los Angeles. They concluded that internal corrosion is the first and the most important factor in the all dams [3].

Geotechnical engineering problems are mainly due to the movement of ground water in underground structures such as seepage in earth dam. Due to the potential energy, water molecules flow in porous soil media and gradually lose their energy. This phenomenon is called soil seepage in porous media which has adverse effects , such as the loss of stored water in the soil structure, pore pressure and reduced effective stress, uplift pressure, movement of soil particles and seepage force on the soil mass [1]. In general, the shape and position of the earth core can be built in three states, vertically at the center of dam, just inclined to upstream (20° to the vertical direction) and the fully inclined to the upstream (40° to the vertical direction).

Inclined core benefits includes: acceleration in the construction of the downstream shell and time-saving in projects, simultaneously with the construction of the downstream shell, injection operations are possible in the following core, and in using inclined core filter thickness can be reduced and used more easily. Inclined core disadvantages include; in the core and foundation contact, pressure is less in the vertical core state. So, the hydraulic failure probability increases and if we want to apply a certain amount of material in the core, vertical core thickness is more than inclined.

Vertical core benefits include: reduced risk of hydraulic failure is the result of the higher pressure at the contact surface of the core and foundation, if necessary, for injection of foundation or in the contact of core and foundation, in the next stages vertically injection boreholes can be done easily compared to inclined condition. Foundation level under the core is independent of the depth. So, corrective actions can be executed earlier. Vertical core disadvantages are: vertical clay core decreases downstream gradient and