

## Postprint: Influence of Underlying Foundation Soil Gradation on Seepage Piping Mechanism in Circular Geomembrane Defects

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### Abstract

In modern solid waste landfills, geomembranes serve as a critical component of bottom liner systems, fulfilling the essential function of preventing leachate contamination of groundwater and protecting the surrounding environment. Addressing tailings storage facilities as high-potential-energy major hazard sources occupying extensive areas, the authors conducted an investigation into the mechanisms of seepage and piping through geomembrane defects under varying underlying foundation soil conditions. The experimental configuration utilized geomembrane defect diameters of 10 mm and 50 mm, a tailings fine particle content of 20%, and three distinct underlying foundation soils corresponding to filter criteria of no erosion, some erosion, and excessive erosion, respectively. The effective stress applied to the tailings ranged from 150 to 600 kPa, with hydraulic heads between 35 and 140 m. Research findings indicate that when the underlying foundation soil satisfies the filter criteria, no piping failure occurs in the tailings and seepage through geomembrane defects is proportional to the defect diameter. In contrast, when the filter criteria are not met, piping failure is easily induced in the tailings, resulting in a two- to threefold increase in seepage, scour of tailings material, and surface collapse. Additionally, the authors investigated the influence of geotextiles on seepage and piping behavior. These findings elucidate the piping failure mechanism and disaster evolution process through geomembrane defects at the base of tailings storage facilities and propose effective, feasible piping prevention technologies, providing guidance for site selection and design of tailings storage facilities.

## Full Text

# Effect of Subgrade Gradation on Leakage and Piping Through a Circular Geomembrane Defect

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## Abstract

Geomembranes constitute a critical component of bottom liner systems in modern solid waste containment facilities, serving the essential function of preventing leachate contamination of groundwater and protecting the surrounding environment. This study investigates the mechanisms of seepage and piping through geomembrane defects under various subgrade conditions, specifically addressing tailings storage facilities—which represent large-scale, high-potential-energy major hazard sources. Experimental parameters included geomembrane defect diameters of 10 mm and 50 mm, a fine particle content of 20% in the tailings, and three subgrade soils corresponding to filter criteria classifications of no erosion, some erosion, and excessive erosion. The applied effective stress on the tailings ranged from 150 to 600 kPa, with hydraulic heads between 35 and 140 m.

The results demonstrate that when the subgrade soil satisfies established filter criteria, no piping failure occurs within the tailings and seepage through the geomembrane defect remains proportional to the defect diameter. Conversely, when filter criteria are not met, piping failure is readily induced, resulting in a two- to three-fold increase in seepage, progressive erosion of the tailings, and eventual surface collapse. Additionally, the influence of geotextiles on seepage and piping behavior was examined. These findings reveal the piping failure mechanisms and disaster evolution processes occurring through geomembrane defects at the base of tailings storage facilities, propose effective and practical piping prevention technologies, and provide valuable guidance for the site selection and design of tailings dams.

**Keywords:** particle gradation; filter criteria; seepage; piping

*Note: Figure translations are in progress. See original paper for figures.*

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