Analysis of the Failure Mechanism of Sandy Bed Soils Due to Pipeline Leaks: Experiments and Numerical Simulations

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Résumé

Pipeline leaks present significant challenges in civil engineering, including water loss, soil erosion, and the formation of settlements or sinkholes. Although several studies have addressed this phenomenon, certain variables remain insufficiently explored, particularly the effects of leak directionality. This research employs laboratory experiments to analyze the impact of pipeline leaks oriented horizontally. The experimental setup consists of a rectangular container filled with sand particles, with a nozzle installed on one of the walls to simulate a pipeline orifice, allowing water to impinge horizontally into the soil. The flow rate from the orifice is varied to assess its eroding impact on the soil. Results indicate that the water streamlines curve upwards, dragging sand particles and forming a protruding mound on the surface. Above the leak, particle restitution creates a cyclic vertical circulation pattern, leading to surface settlement at the leak origin. These experimental findings are contrasted with numerical simulations using CFD-DEM coupling software. The insights gained contribute to a better understanding of the failure mechanism in sandy soils surrounding pipeline leaks, supporting improved risk assessment and mitigation strategies.

Mots-Clés: Pipeline leak, Soil erosion, Sandy bed soils

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