Erosion Tests

The « *Contact Erosion Test* »

When a fine layer of an embankment dam or dike (for example a silty or clayey core…) is in contact with a coarsy layer of the same structure (for example its alluvial foundation…), and when a natural water flow is present within the layers, a « ***contact erosion*** » is likely to appear between the layers and to wash the fine grains from the fine layer. The evolution of this process depends on i) the difference of size of the particles present in the layers and ii) the natural flow rate.

The « **Contact Erosion Test** » or CET is aimed at reproducing this erosion phenomenon in the laboratory.

Two layers that are representative of the actual structure are set up in the apparatus and i) a mechanical stress within the layers is applied (so as to simulate the in situ stress), while ii) a flow is applied to both layers, at varying rates. The resistance to erosion of the reworked soil can be derived from the analysis of the amount of eroded soil .

The CET enables to determine:

- ✓ if the difference of particle size of both layers is sufficiently low so that **a contact erosion between both layers is excluded** or not,
- ✓ the **Darcy velocity** within the coarse layer (and the associated hydraulic gradient) that is requested so that **contact erosion can be initiated**,
- ✓ an estimate of the **permeability *k*** ($m \times s^{-1}$) of the coarse layer.

Technical specifications

The **Erosion Tests Laboratory** offers state-of-the-art erosion tests which enable to quantify the resistance to erosion of soils. The provided results are commonly used as inputs for « ***Diagnostics*** » or French « ***Étude de dangers*** ».

		JET	HET	CET
Application		Overflowing, soil erodability estimate	Concentrated leak erosion	Contact Erosion (between 2 different layers of soil)
Samples characteristics	*In-situ*	Possible (provided there are no particles of size	Impossible	Impossible
	Intact	✓Min dim: Ø ~ 8 cm, h ~ 30 cm ✓Absence of particles > 5 mm	✓Min dim: Ø ~ 8 cm, h ~ 30 cm ✓Absence of particles > 5 mm	Impossible
	Reworked	Min weight of dry soil to provide with : 2.5 kg	Min weight of soil to provide : 2.5 kg	✓Min weight of thin soil to provide : 10 kg ✓Max weight of coarse soil to provide : 2.5 kg

Suffusion Tests (ST) and Crumb Test (CT) : please, contact us.

Contact

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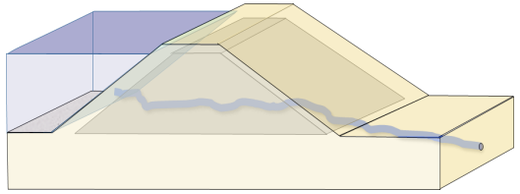
geophy*Consult*

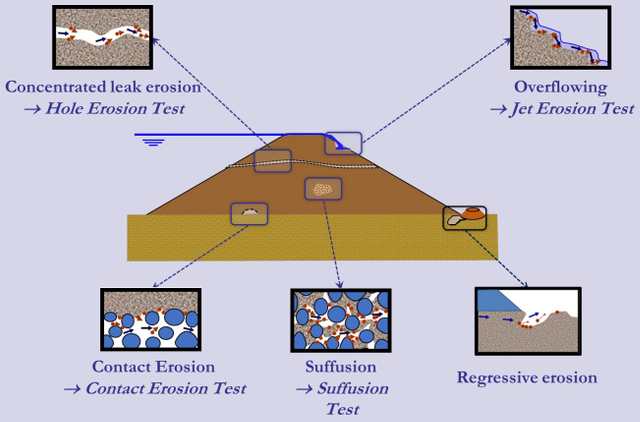
« State-of-the-art technologies for the safety and the monitoring of infrastructures »



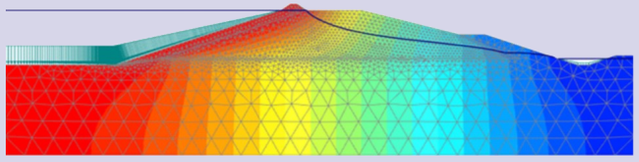
« Erosion risk assessments and Erosion Tests »

Erosion risk assessments

An embankment structure (**dike, levee, dam**…) is subject to **erosion** processes, either at its surface (**scouring, overflowing**) or within its embankment or in its foundation (**concentrated leak erosion**, **contact erosion**). These processes weaken the structure and, in some cases, can lead to its failure. In order to properly handle this risk, one must **quantify** the water flows that appear within or at the vicinity of the structure, and measure the **resistance to erosion** of the soils present in the embankment.



geophy*Consult* **experts** carry out **safety diagnostics of embankment hydraulic structures,** including hydro-mechanical **numerical modelling of the structures** (to characterize the main inner water flows, the mechanical stability of the structure, as well as the **security margins** that can be associated to all the erosion phenomena that are likely to occur).



Erosion tests

The « *Jet Erosion Test* »

During **overflowing**, water runs over the downstream wall, which creates staircases that act like a succession of mini waterfalls which trigger erosion processes. In some cases, these processes lead to the **failure** of the structure.

The « *Jet Erosion Test* » or JET has been developed in order to reproduce the overflowing erosion phenomenon on cores. It consists in applying a vertical water jet on the axis of the core and monitoring the depth of the generated scour. The test quantifies the resistance to erosion of the soil.

The JET carried out at *geophyConsult* (which is derived from the American standard ASTM D5852) enables to determine:

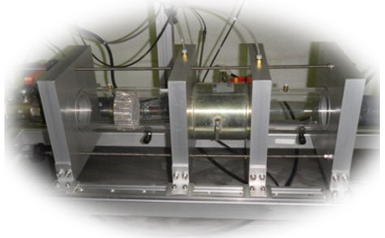
- ✓ the position of the soil in the existing soils classifications with respect to erosion rates ;
- ✓ the value of τ_c parameter, which addresses the hydraulic conditions required to **initiate** the erosion process ;
- ✓ The value of the κ_d parameter which, associated with τc in an erosion model (windam, hr -breach…), enables to estime the kinetics of a possible breach .

The test has been carried out all around the world on very different types of soil. It gives a first rough estimate of the erodibility whatever the erosion process (overflowing as well as other types of erosion processes). This is why it can be used to compare various types of possible refilling, or to compare the erodibility of different layers of a given soil. When the analysed processes are not linked to overflowing, the studies are generally qualitative rather than quantitative

The « *Hole Erosion Test* »

In case a defect pre-exists in an embankment hydraulic structure (root, racoon-hole, etc.), the defect tends to widen when the structure is subject to significant a hydraulic head (> a few meters). Depending on the characteristics of the soil, etc., the leak associated with the defect can rapidly evolve into a **breach**, in the worst case in 4 hours (see, above, the « *Teton Dam* » breach, in 1976 – h = 93 m and V = 350 millions of m³).

The « *Hole Erosion Test* » or HET has been developed to reproduce the erosion phenomenon in a core. To do so, an artificial hole of 6 mm diameter is pre-drilled in its axis and a controlled water flow is imposed in the conduit so that it can **widen** it, while the evolution of diameter is monitored. The test determines the resistance to erosion of the soil.



The HET carried out at geophy*Consult* (under **INRAE** licence) enables to determine :

- ✓ the position of the soil in the Fell classification of soil erosion rates (which varies from « *Extremely rapid* » to « *Extremely slow* ») ;
- ✓ the τ_c parameter, which addresses the hydraulic conditions required to **initiate** the erosion process ;
- ✓ the I_e index, which can be used to calculate **how fast a small erosion can lead to a major failure**