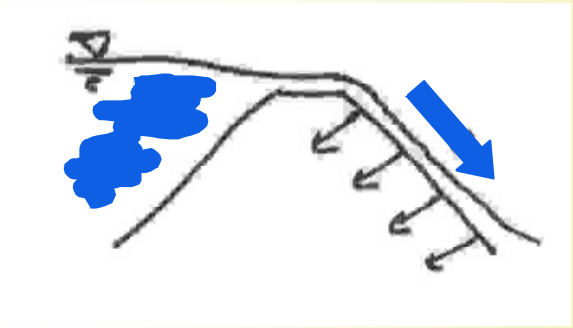
International Workshop on overflowing erosion of dams and dikes
11 – 14th December 2017 - AUSSOIS, FRANCE



IRSTEA Research

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National Research Institute of Science and Technology for Environment and Agriculture

National Research Institute of Science and Technology for Environment and Agriculture

Irstea is a public research institute focusing on continental surface waters, environmental technologies and land management

- 9 sites in France
- 1600 people **including** 500 scientists**, and** 240 **PhD and post-doctoral students**

Geomechanics and Civil Engineering team in Aix-en-Provence

- 35 people
- 12 PhD students
- A soils mechanics laboratory
- Main topics
  - Geomechanics, erosion, and hydromechanics instabilities
  - Performance and safety of dams and dikes

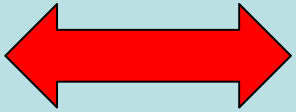
Field observations

Identification of elementary processes and mechanisms

Laboratory tests

Small scale study of elementary mechanisms
in controlled conditions

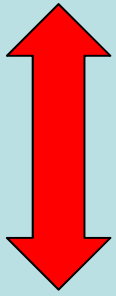
Scale effect



Large scale tests

Large scale study of elementary mechanisms
in controlled conditions

Complexity



Models
(theoretical, numerical)
Consistency of models
(y/c rules of thumb)

Small scale physical models

All the complexity of the phenomenon on a small scale

Case studies

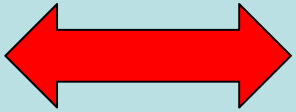
All the complexity of the phenomenon at scale one

Overflowing

Identification of elementary processes and mechanisms ?

Laboratory tests
Jet erosion test

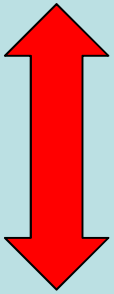
Scale effect



Large scale tests

Overflowing field test

Complexity



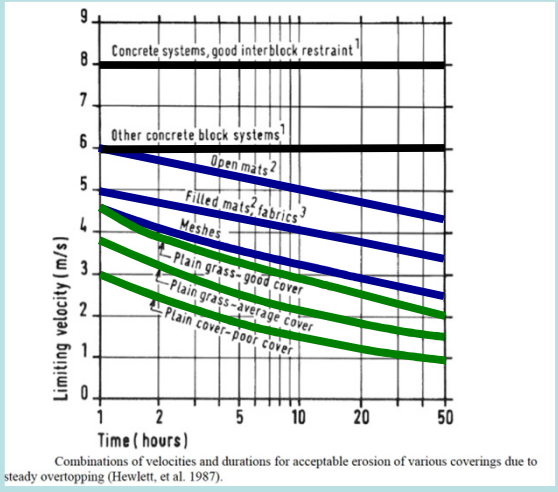
Models
(theoretical, numerical)
Consistency of models
(y/c rules of thumb)

Small scale physical models
Small dikes in lab flumes

Case studies
To be documented

Overflowing resistance analysis of *surface protection*

Curves (CIRIA …)



Combinations of velocities and durations for acceptable erosion of various coverings due to steady overtopping (Hewlett, et al. 1987).

Large scale tests (CSU …)

Overflowing resistance analysis of *embankment soil*

Jet erosion test

Overflowing field test

We are currently developing an overflowing field test

Objectives:

- to quantify the soil resistance of the embankment to an overflow
- to be able to test the dike without modifying the soil in place
- to better understand an overflow
- to better understand the relationship between an overflow and a jet test

Large scale test: Overflowing field test

- Procedure based on ASTM D6460 (2012)
- Each channel : width 61 cm , length 15 m
- Pumping capacity: 2160 m^3/h
- No modification of the dike soil
  => taking into account leaks caused by erosion
- Flow rate, flow velocity and flow depth measurement
- Terrestrial Lidar (laser scanner) to measure erosion

Large scale test: Overflowing field test

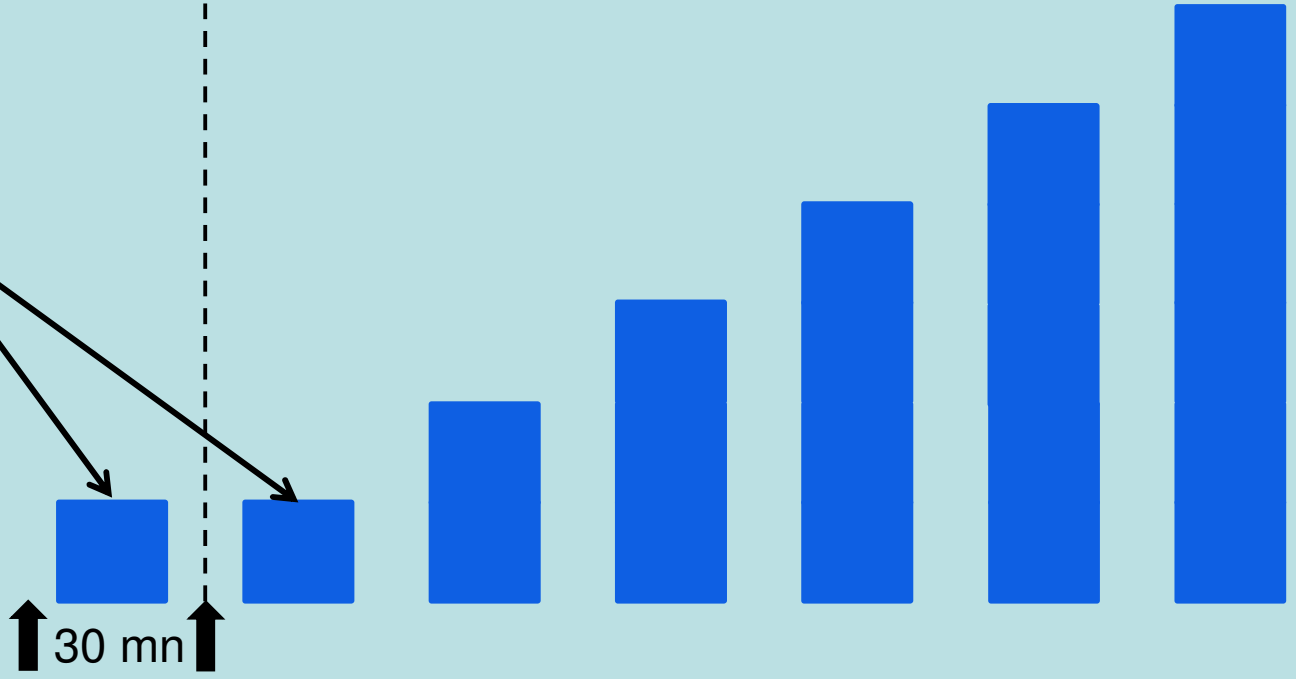
- Incremental increase of the flow rate : each step=30 mn
- Max incoming flow rate : 600 l/s/mL
- Max velocity (downstream toe) : 6 m/s
- Max flow depth (crest) : 30 cm
- Test duration : 4h30

Surface layer erosion

Erosion of embankment soil

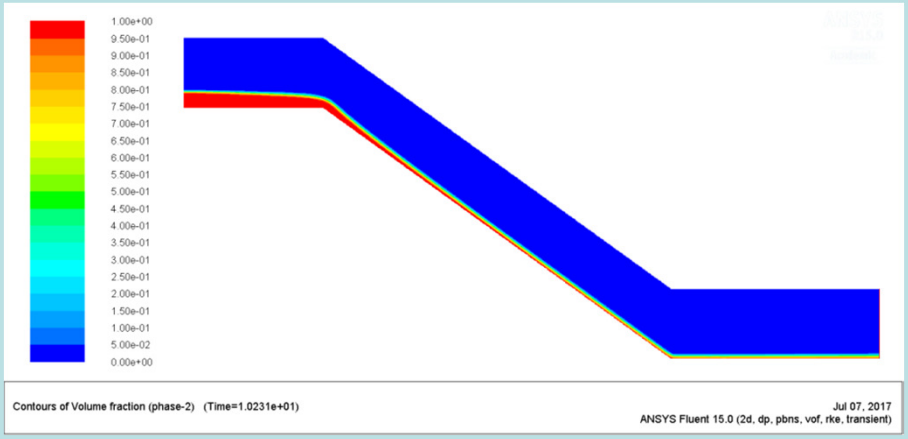
600 l/s/mL

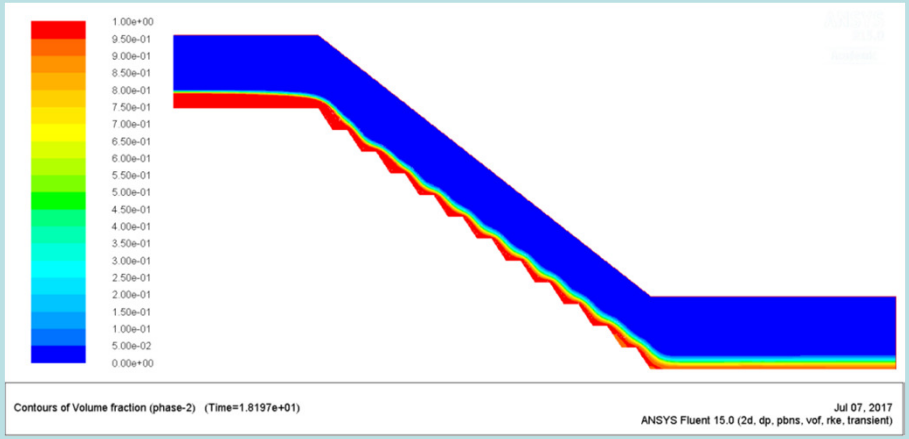
During each step of 30 mn:
Flow rate, Flow depth
Flow velocity measurements

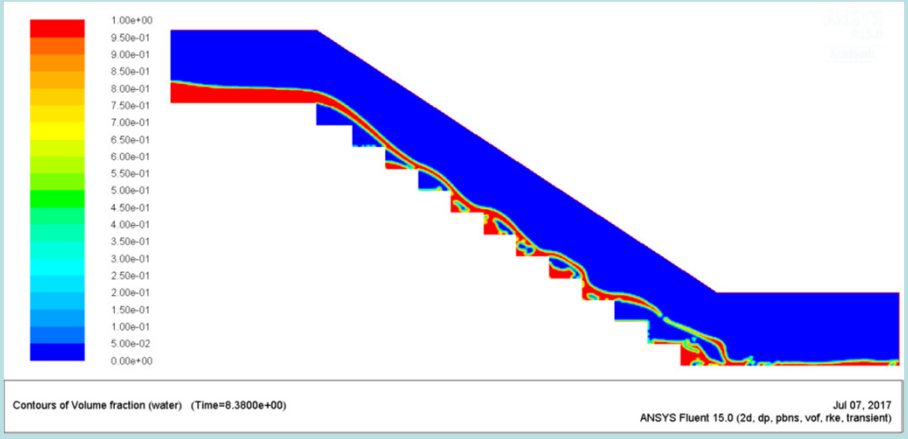


Between each step: terrestrial Lidar measurements (laser scanner)

Large scale test: Overflowing field test







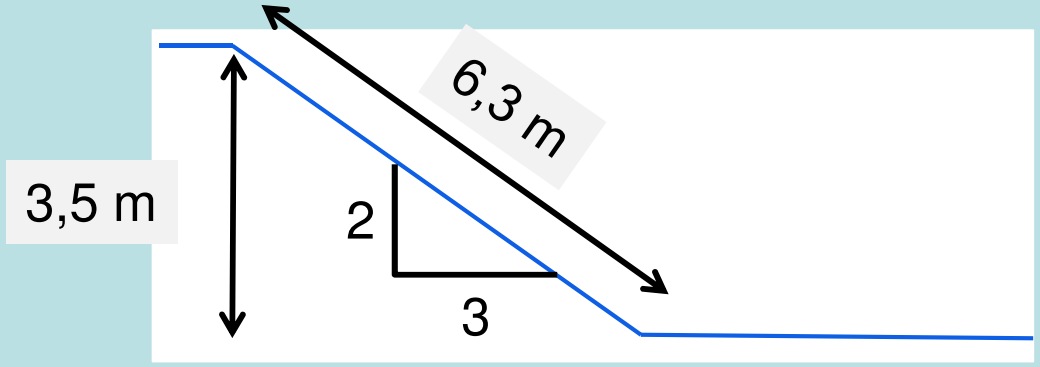
CFD numerical modeling

Smooth slope

These steps appear with erosion
They are the consequence of the layered construction of the embankment

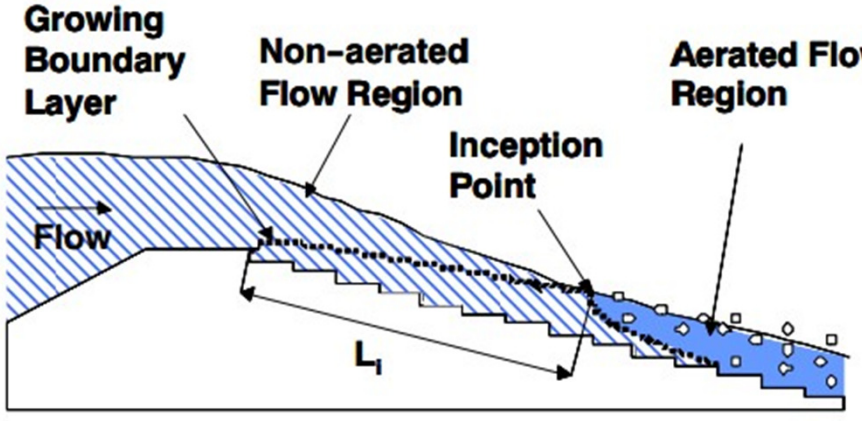
Stepped slope
Step high=28 cm

Large scale test: Overflowing field test



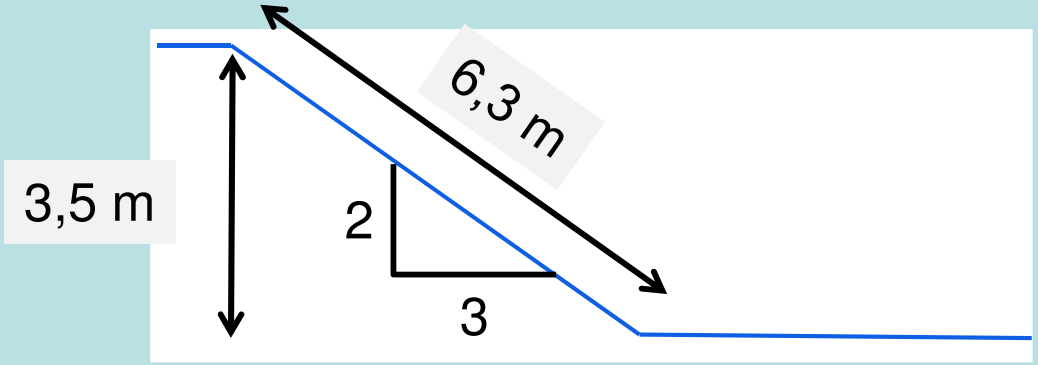
Aerated flows over a steep stepped slope

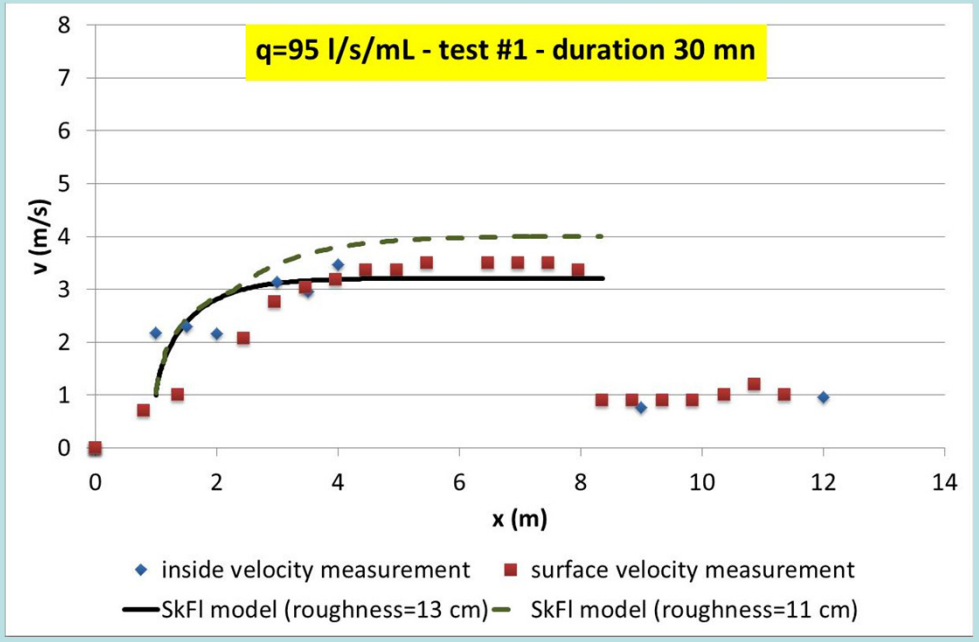
The Chanson model (1994) is used for measurement analysis



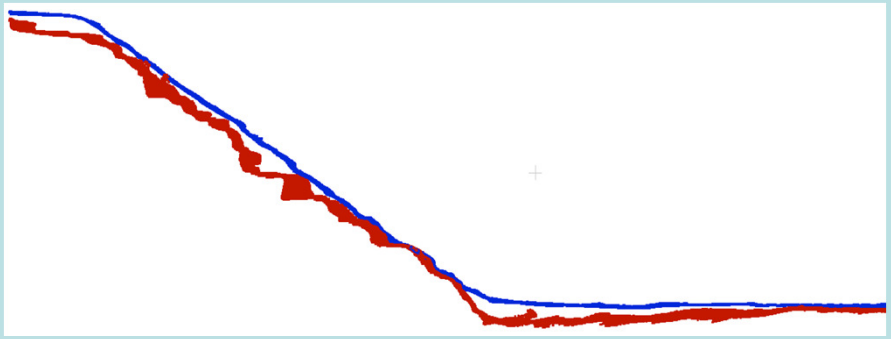
Low flow rate

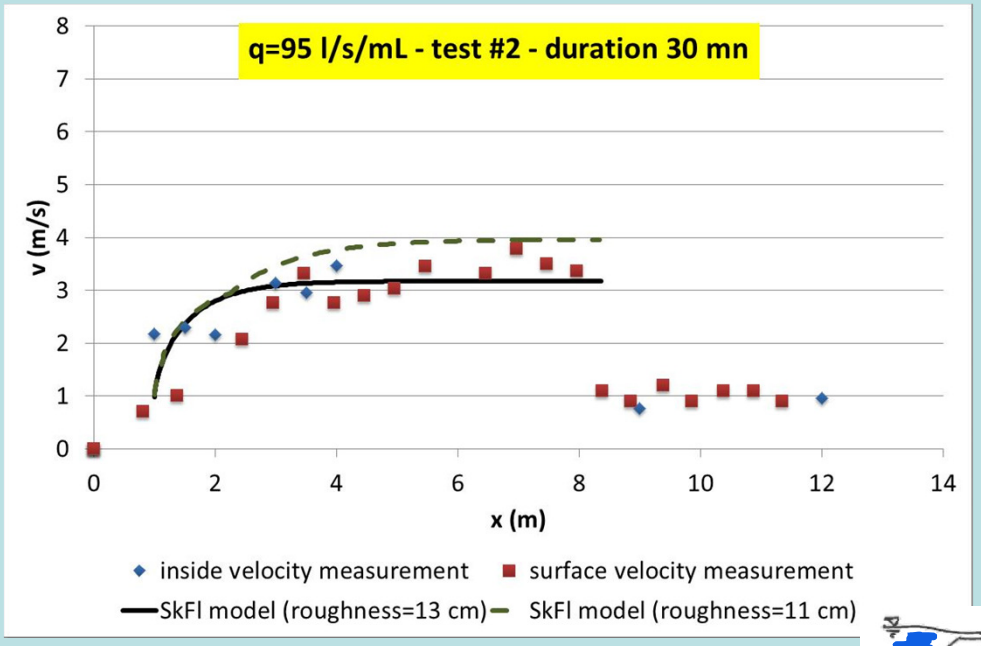
Slope initially not eroded
q=95 l/s/mL





Slope eroded by test #1
q=95 l/s/mL

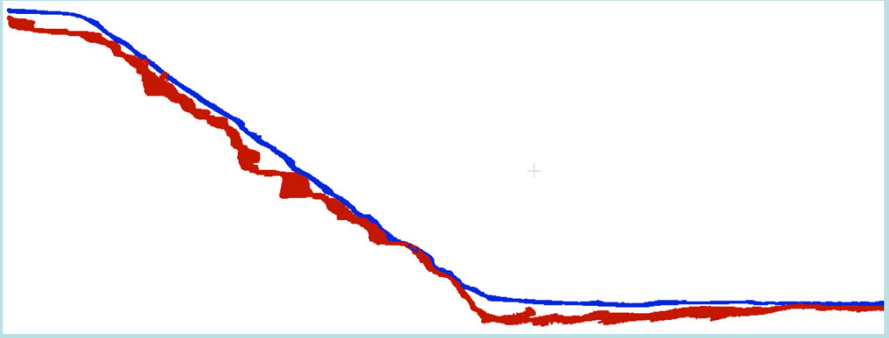


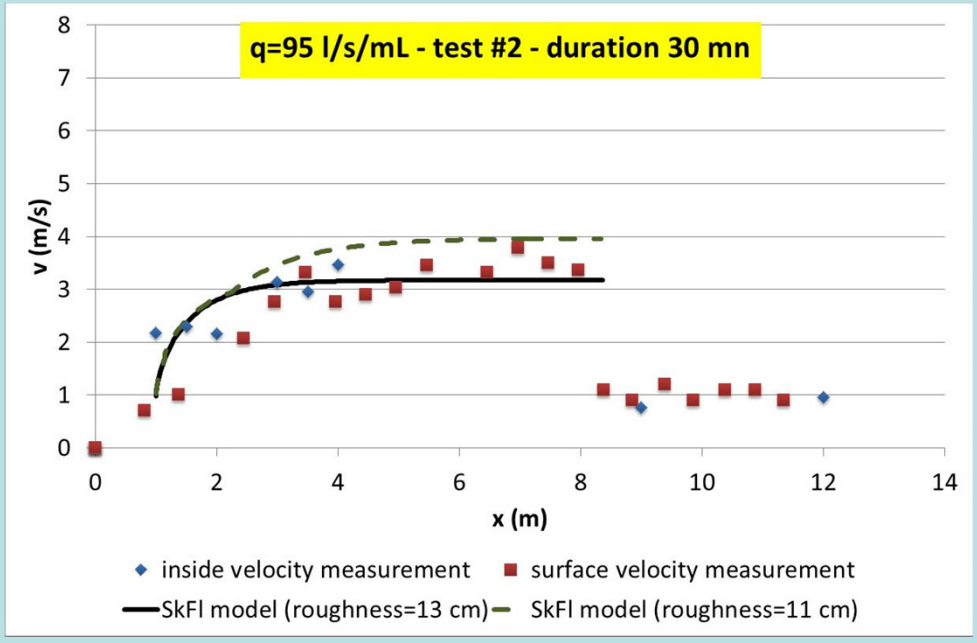


Overflowing field tests - velocities

Low flow rate

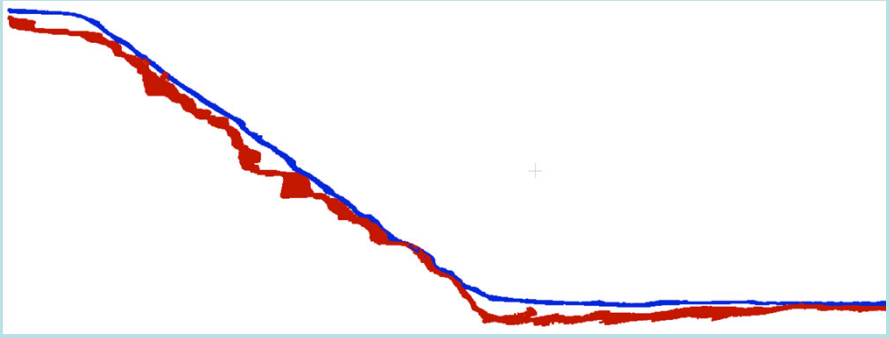
q=95 l/s/mL

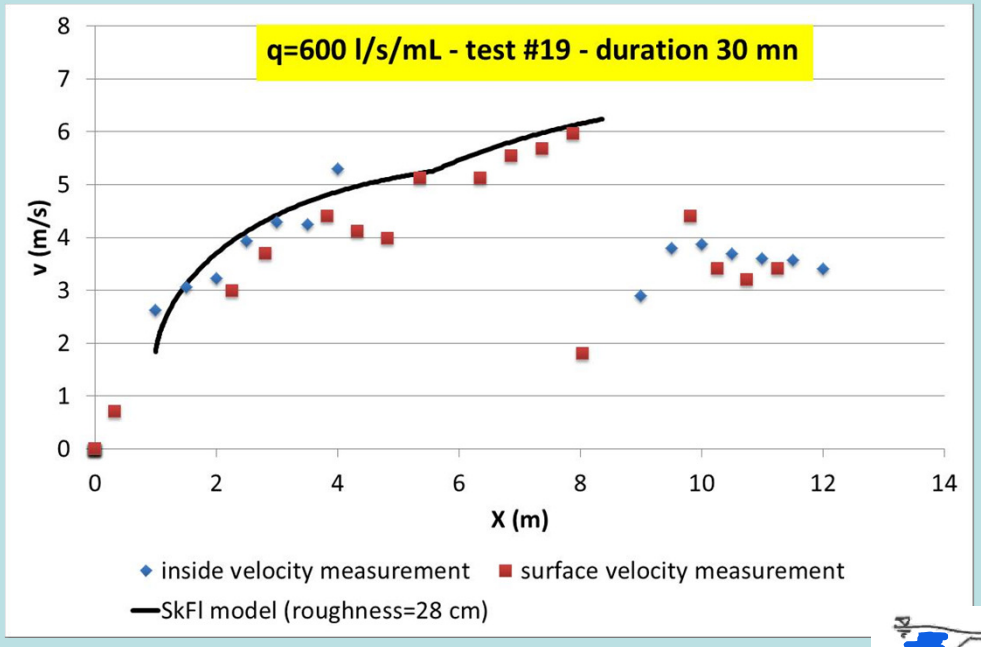




High flow rate

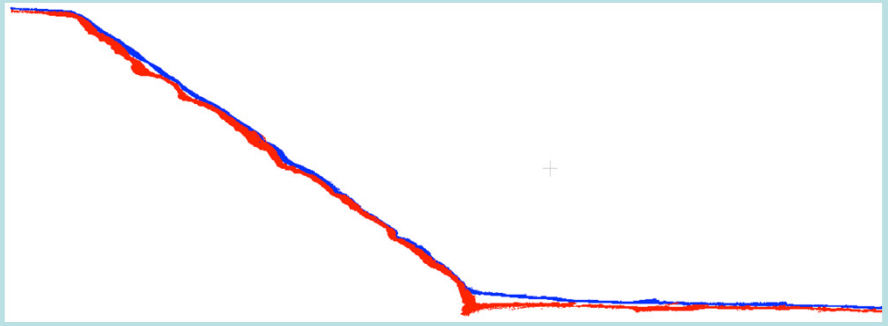
q=600 l/s/mL

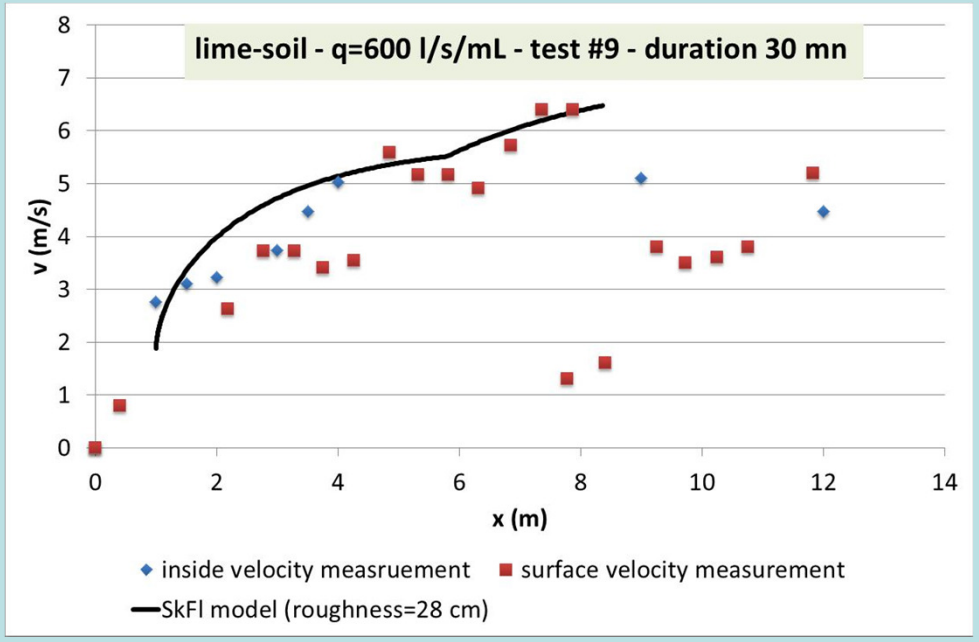




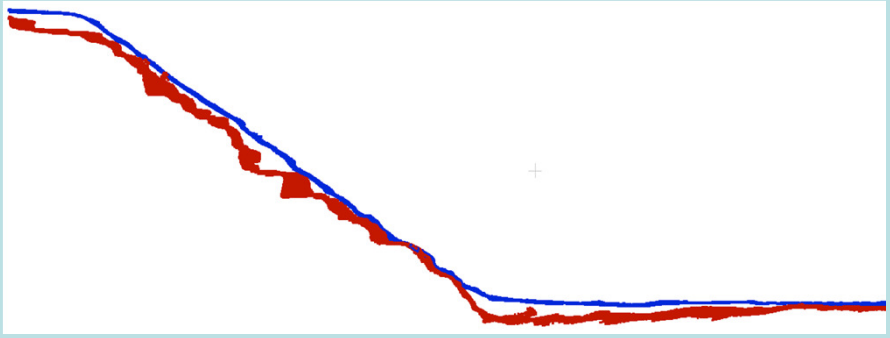
High flow rate
q=600 l/s/mL

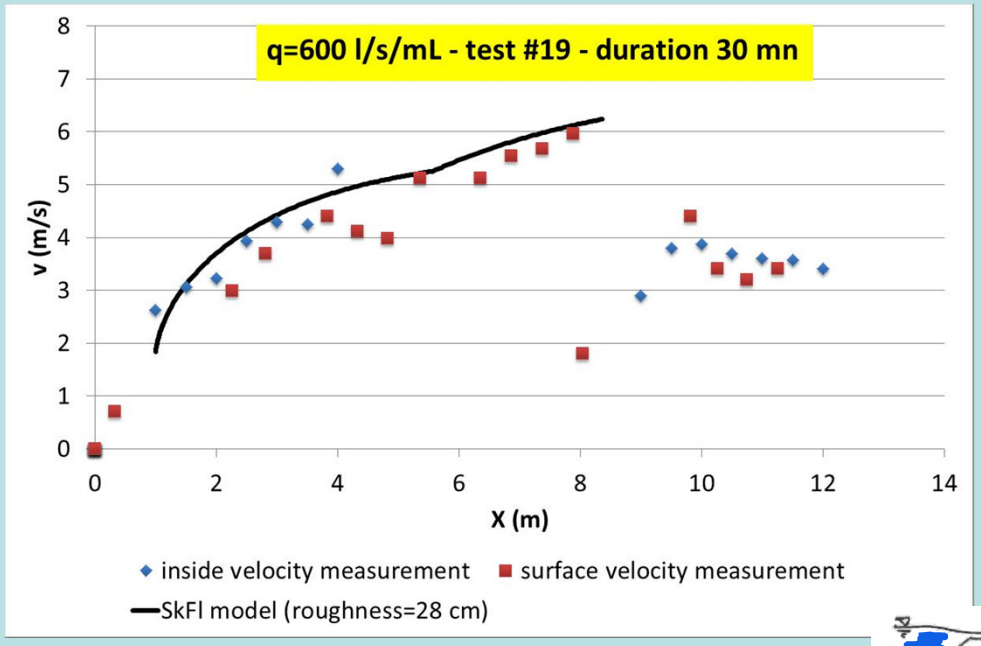
Lime treated soil



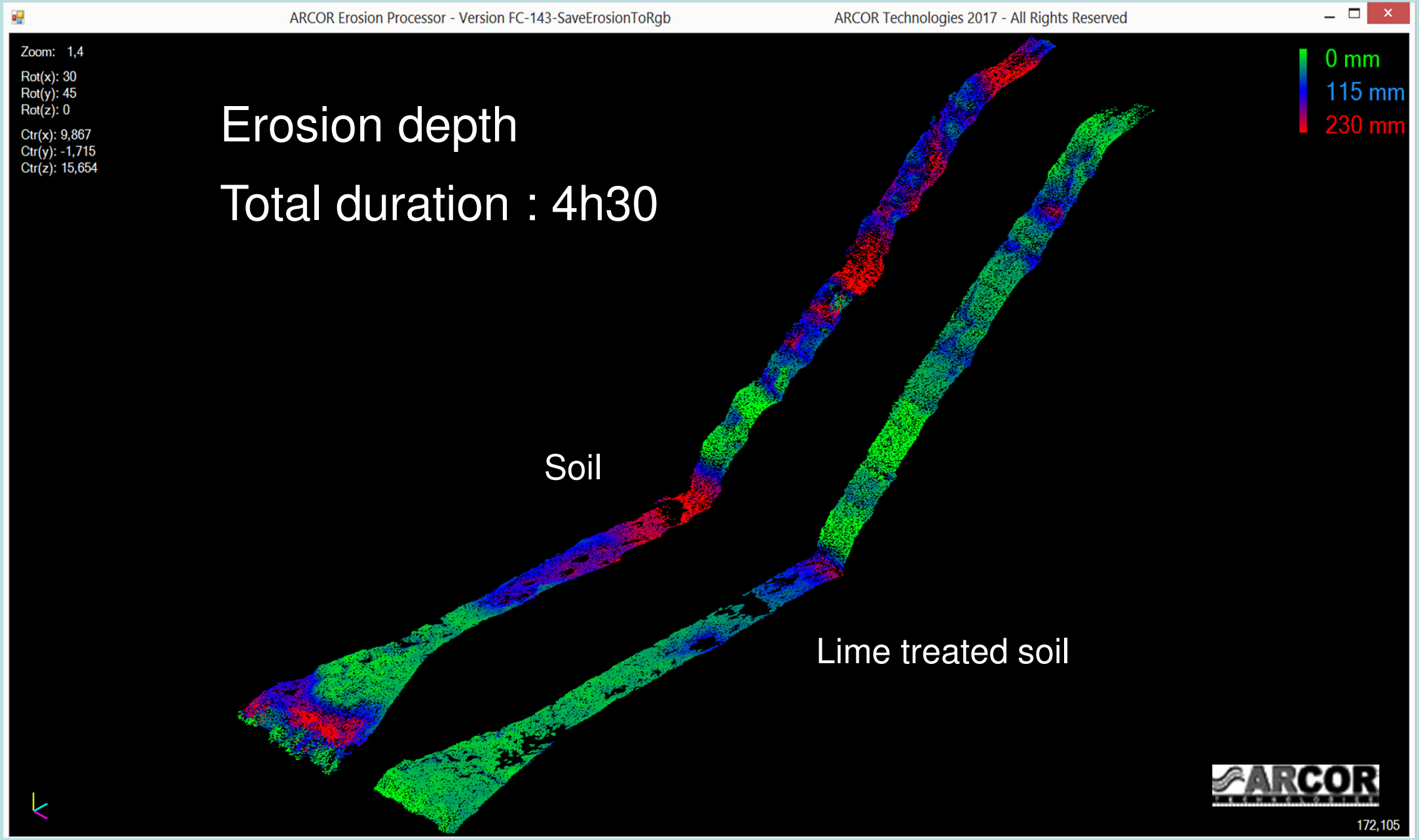


Soil





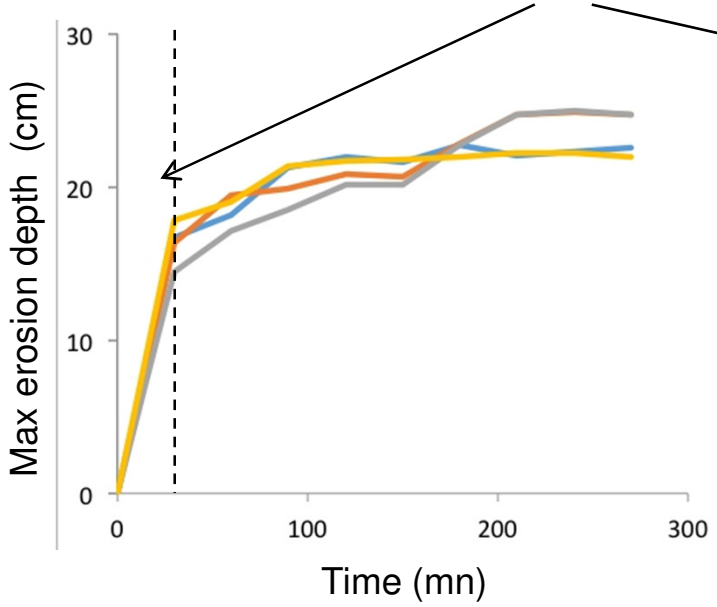
Overflowing field tests – erosion

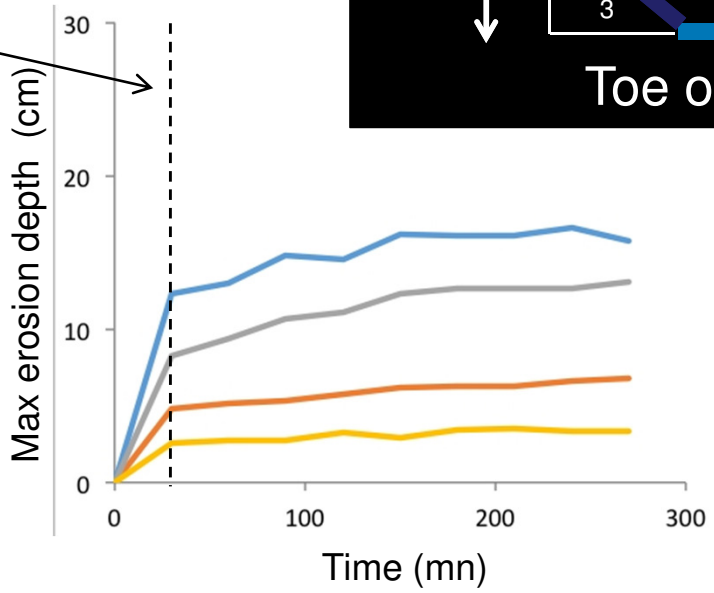


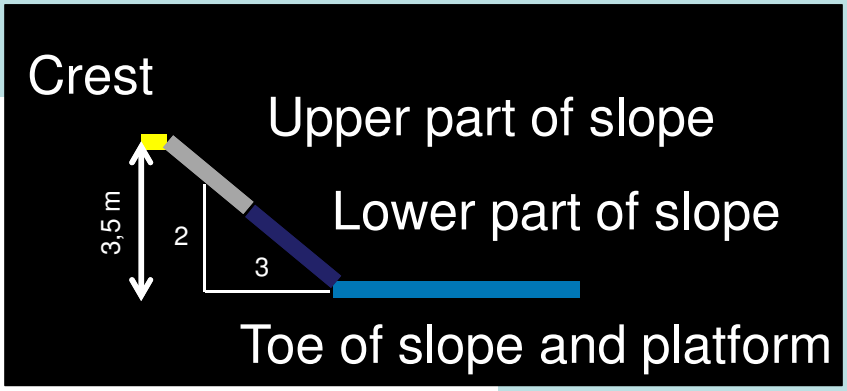
Results obtained by terrestrial Lidar (laser scanner) - Arcor Technologies

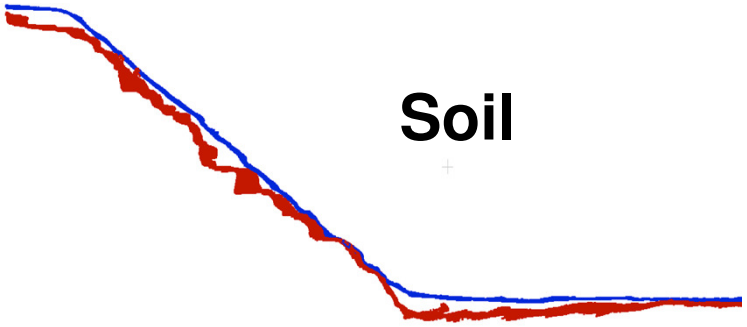
Overflowing field tests – erosion

Surface layer erosion between tests #1 and #2

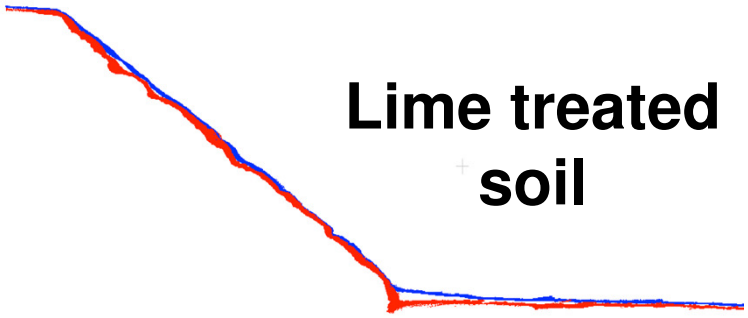








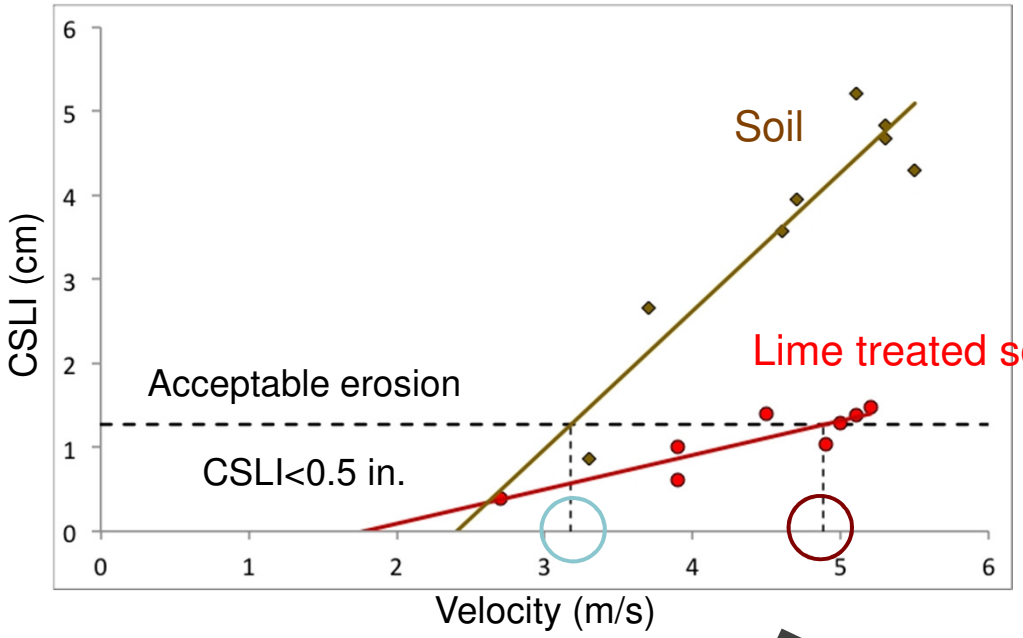
Soil



Lime treated soil

Results obtained by terrestrial Lidar (laser scanner) - Arcor Technologies

Field overflowing tests – erosion

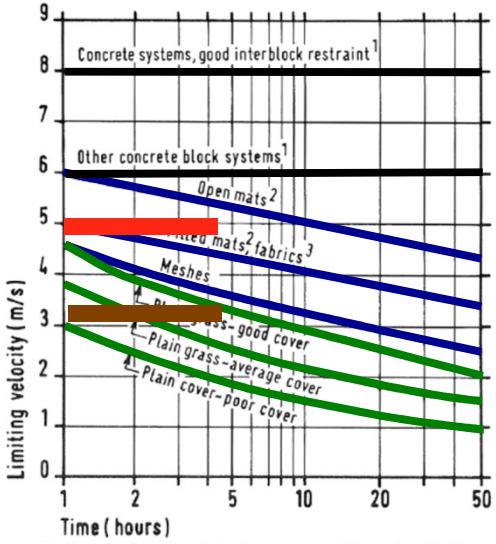


Evaluation of velocities corresponding to acceptable erosion according to ASTM D6460

(Clopper Soil Loss Index)

$$CSLI = \frac{\text{Eroded volume } (m^3)}{\text{Surface } (m^2)}$$

CIRIA Curves



Combinations of velocities and durations for acceptable erosion of various coverings due to steady overtopping (Hewlett, et al. 1987).

Lime treated soil

Soil

CSLI obtained by terrestrial Lidar (laser scanner) - Arcor Technologies