Landfill Mining Stability and Operation

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CO-ORGANIZED WITH

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wasteresource
raw material and by-product exchange

General Council of Catalan Chambers of Commerce

Landfill mining
Stability and operation

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Introduction

01 INTRODUCTION

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Landfill Mining. Different goals

- ✓ Recovery of recyclable materials
- ✓ Materials for energy production
- ✓ Landfill reclamation
- ✓ Corrective measures for technical problems from "old landfills"

Main technical issues to address

- ✓ Excavation Plan
- ✓ Disposal/Refilling plan
- ✓ Leachate levels & management
- ✓ Internal combustion
- ✓ Fire-induced
- ✓ Odour nuisances
- ✓ Other environmental impacts

Key Economic factors

- ✓ Composition of waste & material price
- ✓ Existence of sorting plant
- ✓ Valorisation plant

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Stability. Mechanical characterization

STABILITY. MECHANICAL CHARACTERIZATION

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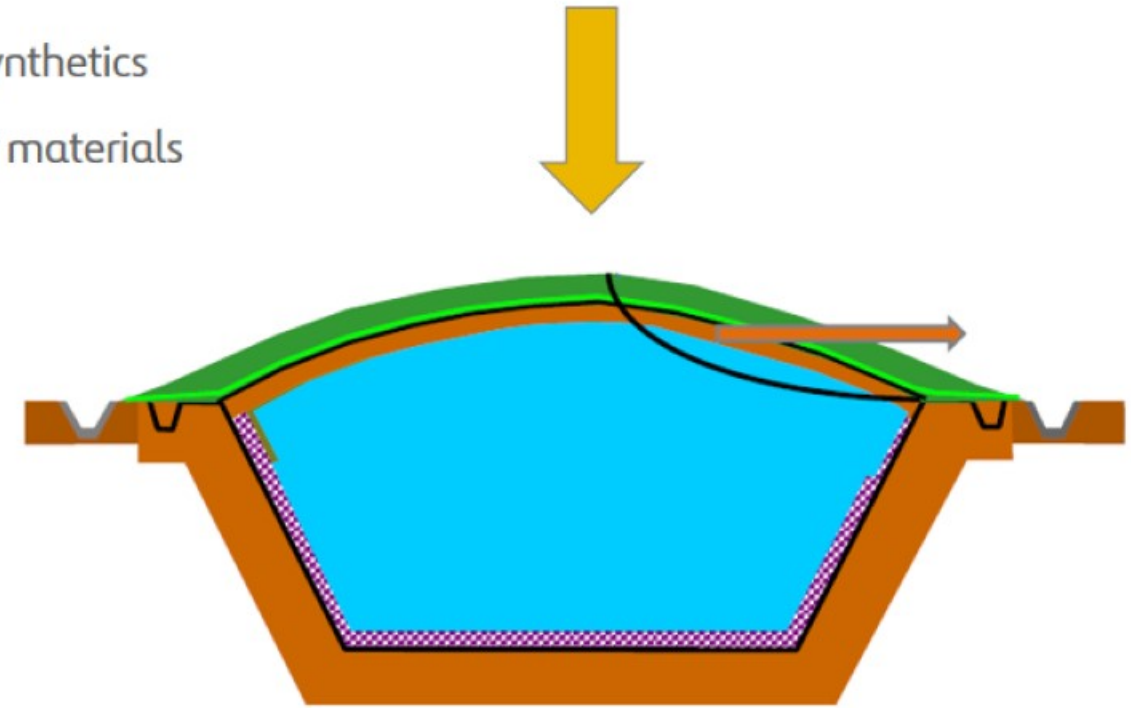
Landfill stability

- Soil mechanics as a reference to describe mechanical behaviour

STABILITY. MECHANICAL CHARACTERIZATION

Landfill stability analysis

- Awareness of the importance of the knowledge of mechanical properties:
  - ❑ MSW
  - ❑ Geosynthetics
  - ❑ Other materials



- ❖ Final cross-sections?
- ❖ Which is the most unstable section? Intermediate section when excavating or refilling?

02 STABILITY. MECHANICAL CHARACTERIZATION

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Geotechnical parameters

- ❑ Laboratory tests
- ❑ "In situ" tests
- ❑ Back-analysis

Laboratory tests

Laboratory testing: shear test and triaxial

The main problems behind laboratory testing are:

- ➢ Lack of representativeness of the samples
- ➢ Relationship between sample size and particles size
- ➢ Sanitary problems

Field tests

"In situ" tests are more representative of geotechnical parameters for the whole mass, due to many factors are directly considered when testing.

Additionally, from an economic point of view it is possible to carry out more test and obtain more data. On the other hand also present drawbacks like:

- ✓ Less control of boundary conditions
- ✓ More complex interpretation
- ✓ Correlation to obtain parameters

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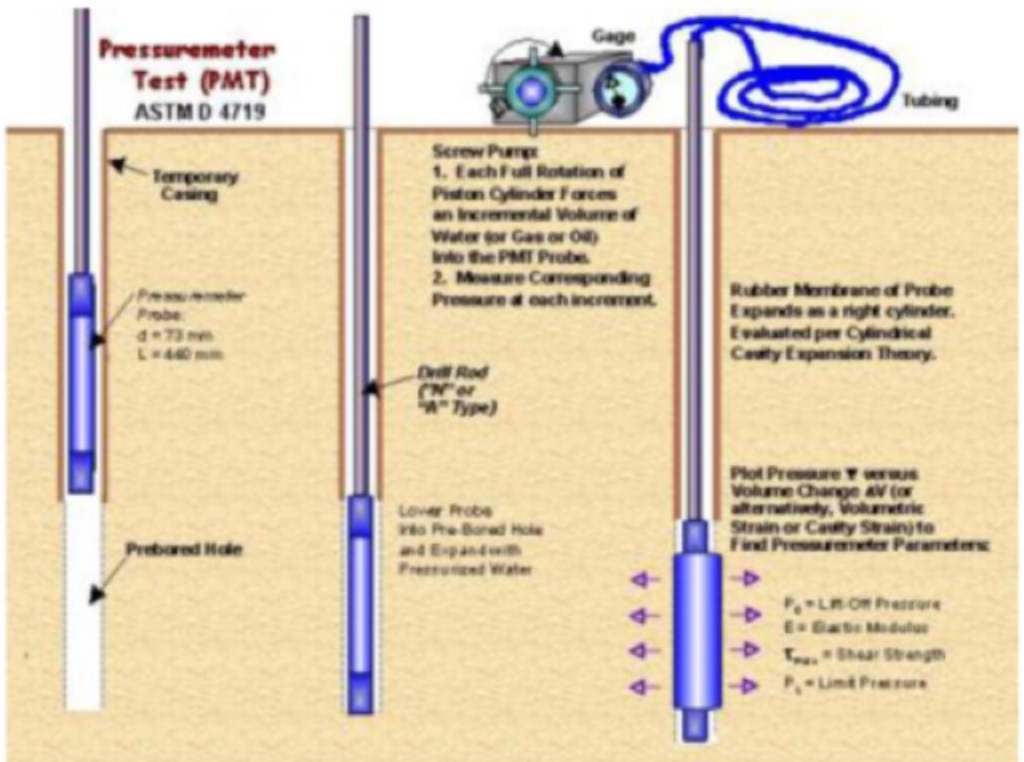
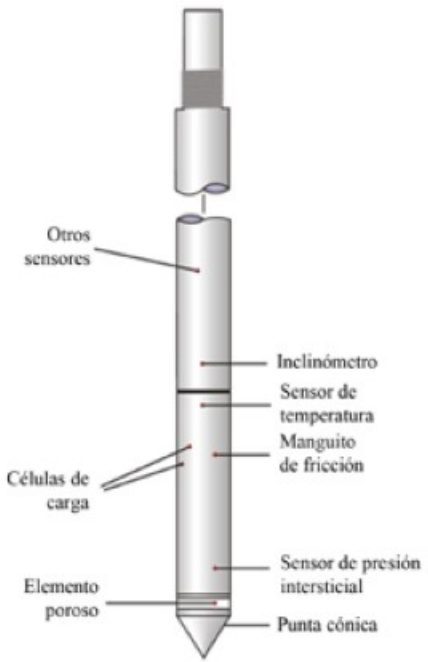
Field studies carried out

- ❑ Pre-Bored Pressuremeter (PBP) **(53 tests)**
- ❑ Depth: 20 m CPT & PBP
- ❑ Cone Penetration Test (CPTu) **(32 soundings)**





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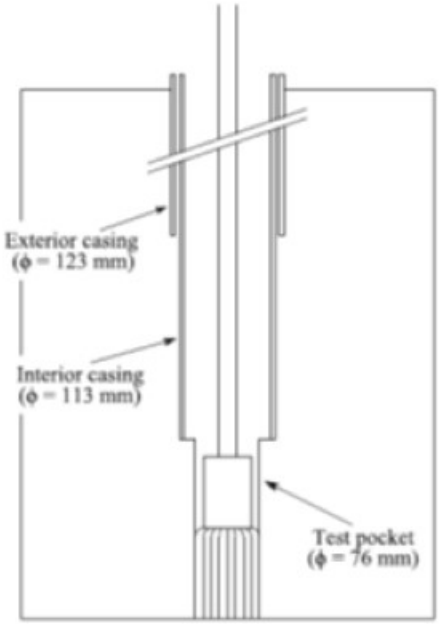
PBP TESTS

Testing methodology

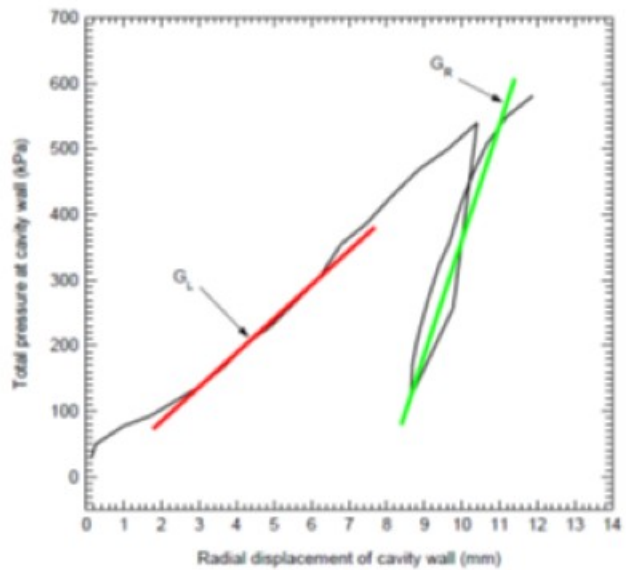
- Pre-Bored Pressuremeter (PBP). Technical problems and methodology:
  - ✓ Selection of the apparatus to produce large strains encountered in MSW
  - ✓ Instability when drilling. Case and double casing for deep boreholes
  - ✓ Membrane selection (soft). Good performance without a noticeable reduction in its durability
  - ✓ Tests were conducted following the ISO 22476-4 standard

Data analysis

- Stiffness; Models for shear strength
- Poor adjustment or no adjustment for shear strength
- G_L moduli and G_R



Deep borehole schematic drawing



GL and GR from a pressuremeter curve

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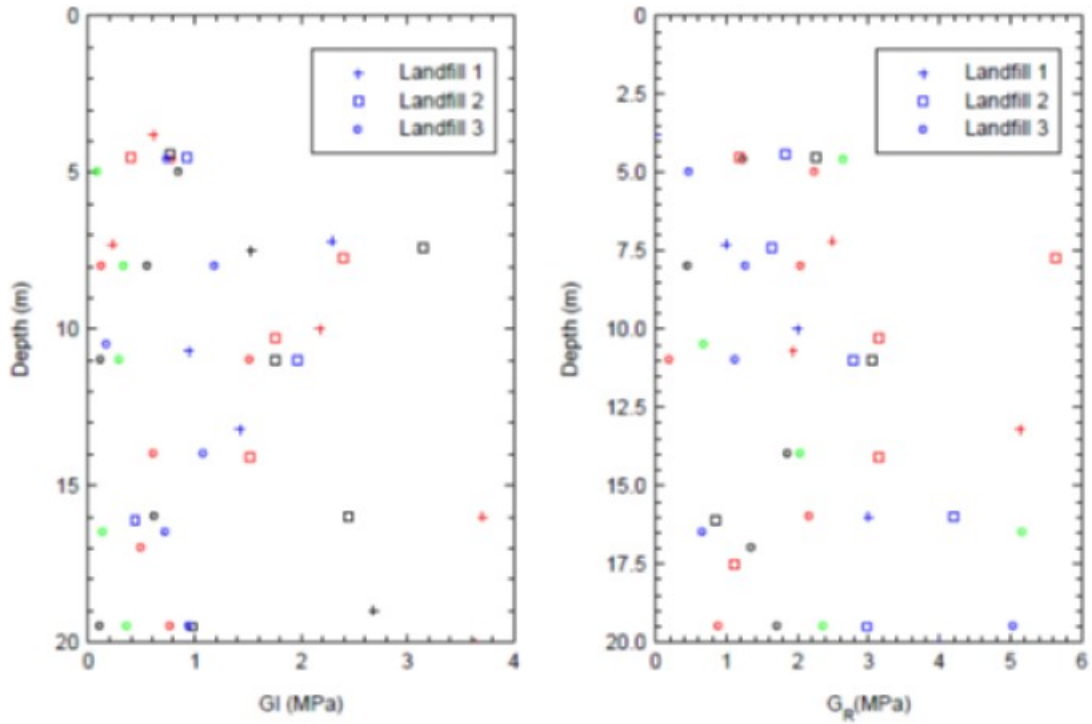
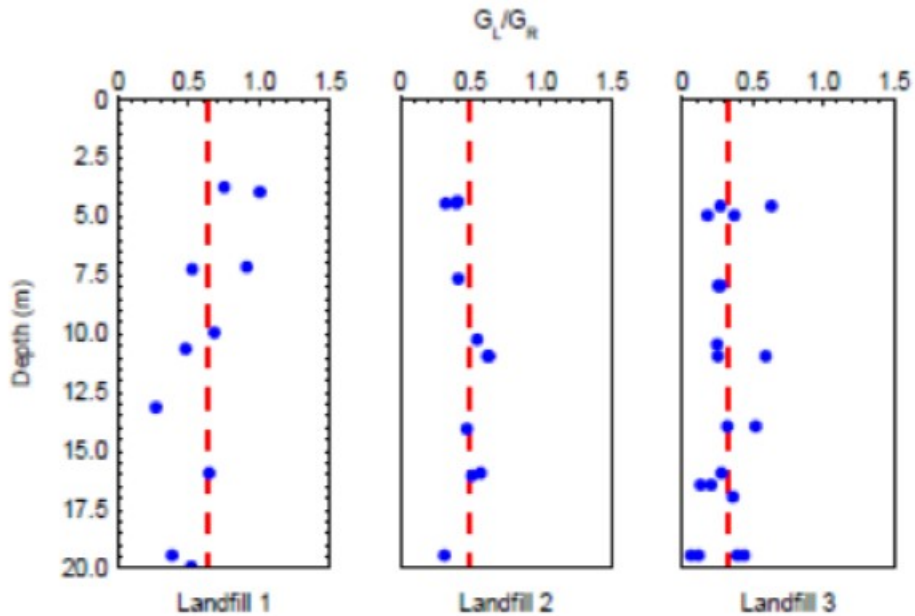
PBP TESTS

Results

- GL and GR; General trend to increase with depth (homogenous behaviour)
- Ratio of GL vs GR constant; SBT (homogeneous)





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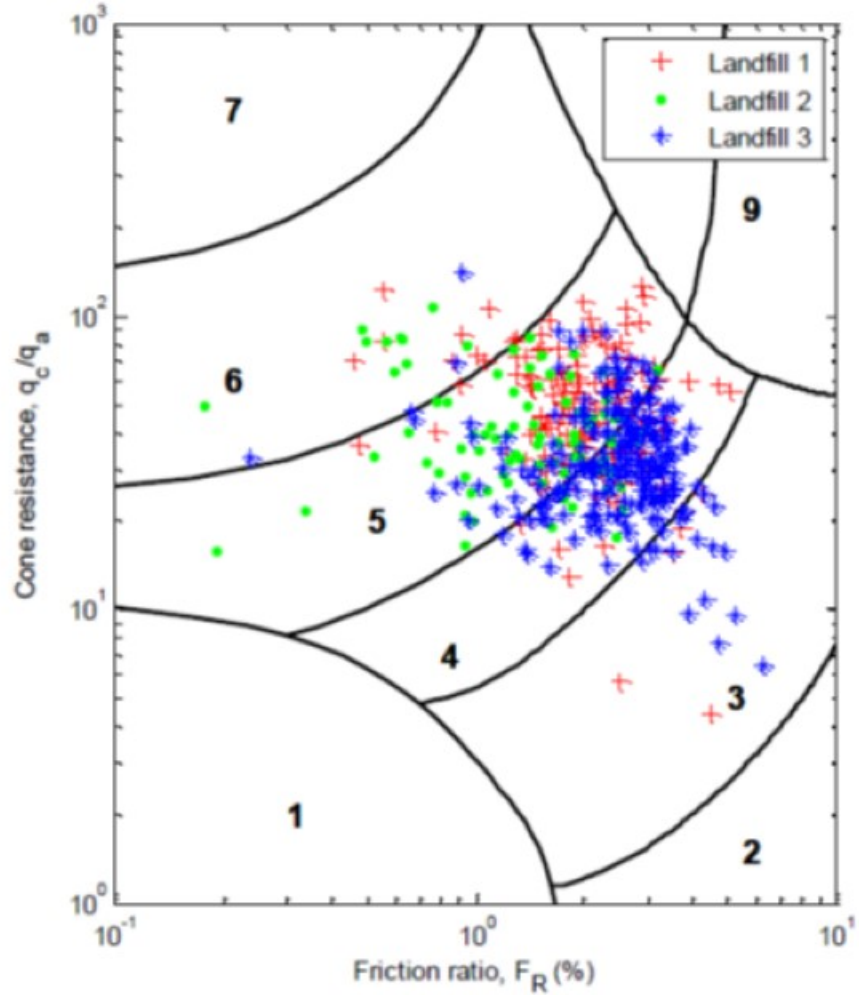
CPTU TESTS

Testing methodology

- Cone Penetration Test (CPTu)
  - On-truck CPTu testing equipment

Data analysis

- Two steps: soil behavior type (SBT) identification and afterwards shear strength was obtained
- SBT provided by commercial software designed for soils was not capable of providing realistic soil type profiles on landfills. Drastic changes every few centimeters
- Manual analysis was done averaging the data and finding ranges of equal mean behavior
- Soil behavior type was determined using the non-normalized chart proposed by Robertson (2010). Waste mass can be assimilated with the one observed in sands and sand mixtures
- Shear strength. Chart by Robertson and Campanella (1983)



Robertson (2010) chart for the 3 sites

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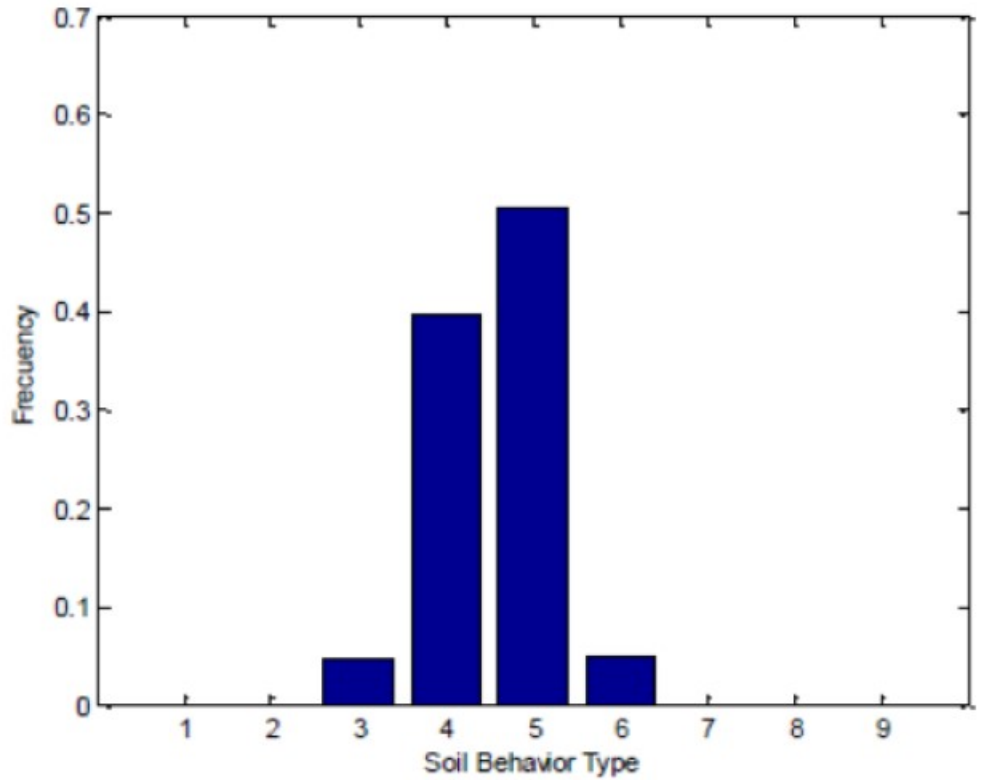
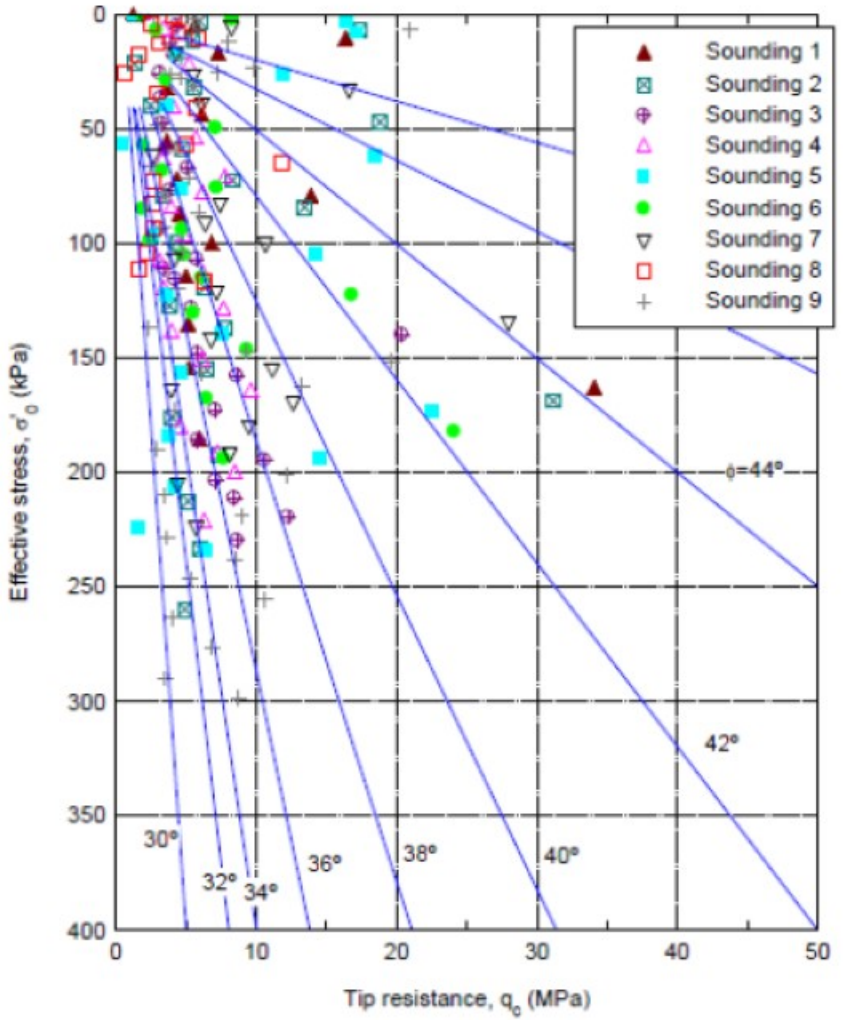
CPTU TESTS

Results

- Sand mixtures or silt mixtures (zone 5, zone 4)
- Most of the points in zone 4 correspond to Landfill 3, showing a different response than the other two.





Results for landfill 1

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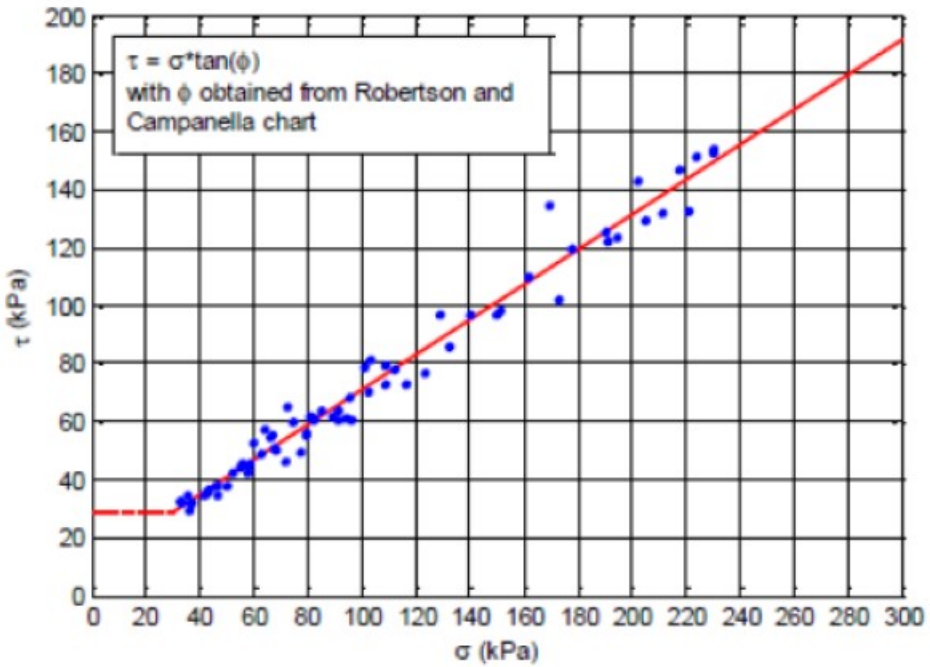
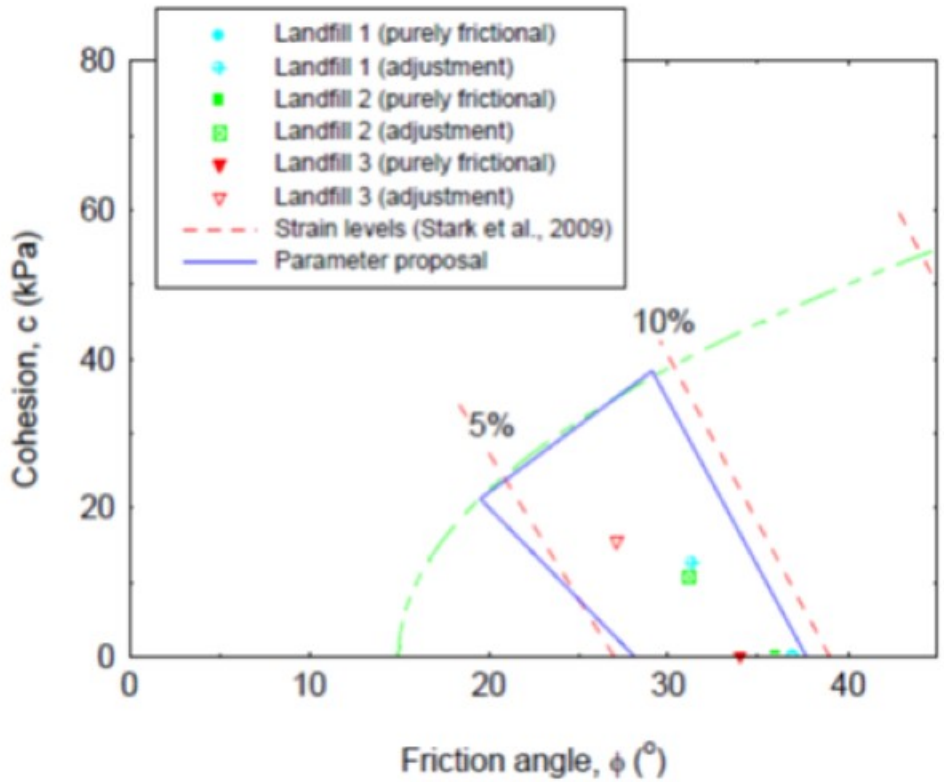
CPTU TESTS

Results

- Adjustment
- Normal stress higher than 30 kPa





Data on parameter proposal

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Other technical aspects & LM operation

OTHER TECHNICAL ASPECTS & LM OPERATION

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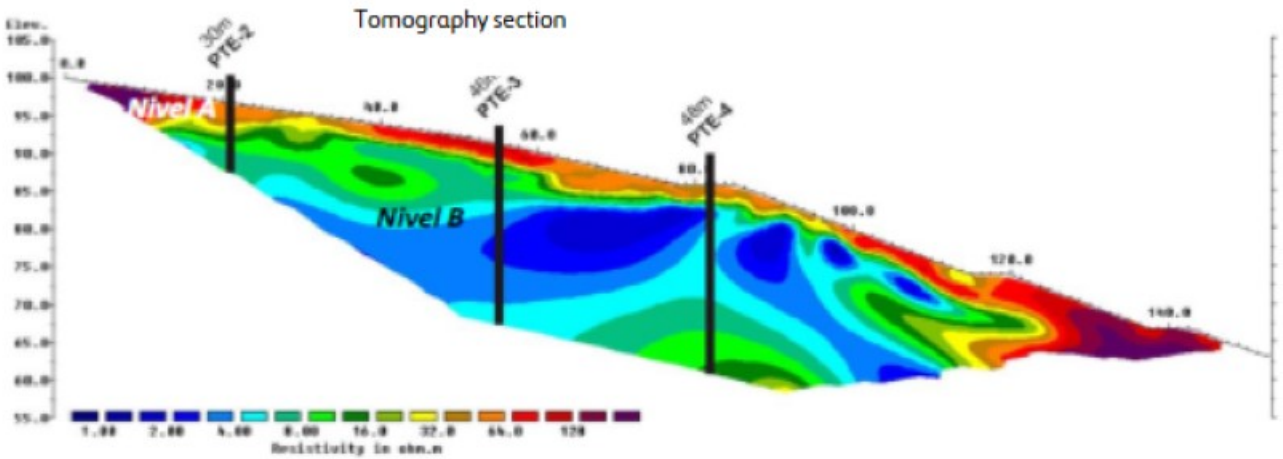
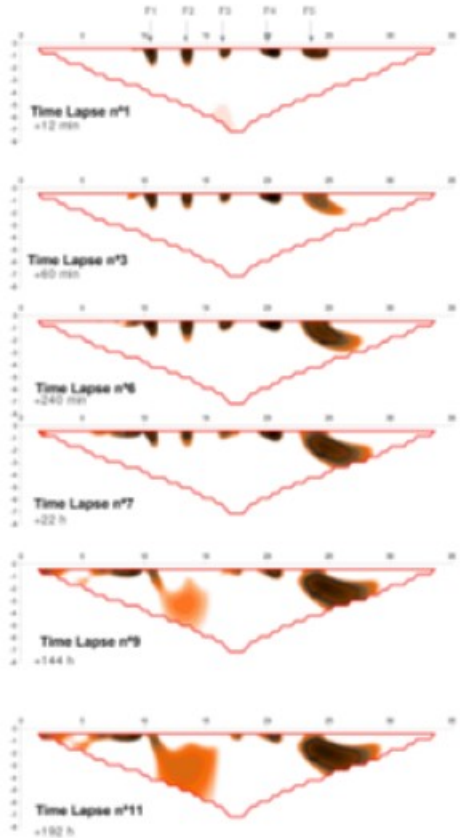
Leachate Levels

- ✓ Leachate levels. Slope stability
- ✓ Influence in Landfill Mining
- ✓ Excavation plan. Leachate management





03 OTHER TECHNICAL ASPECTS & LM OPERATION

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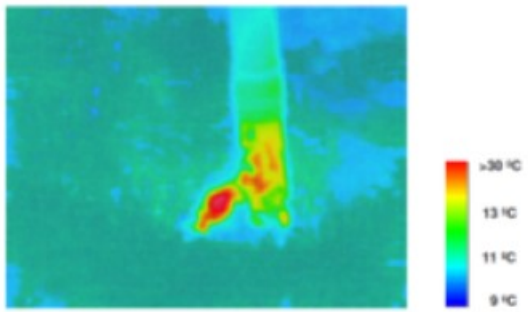
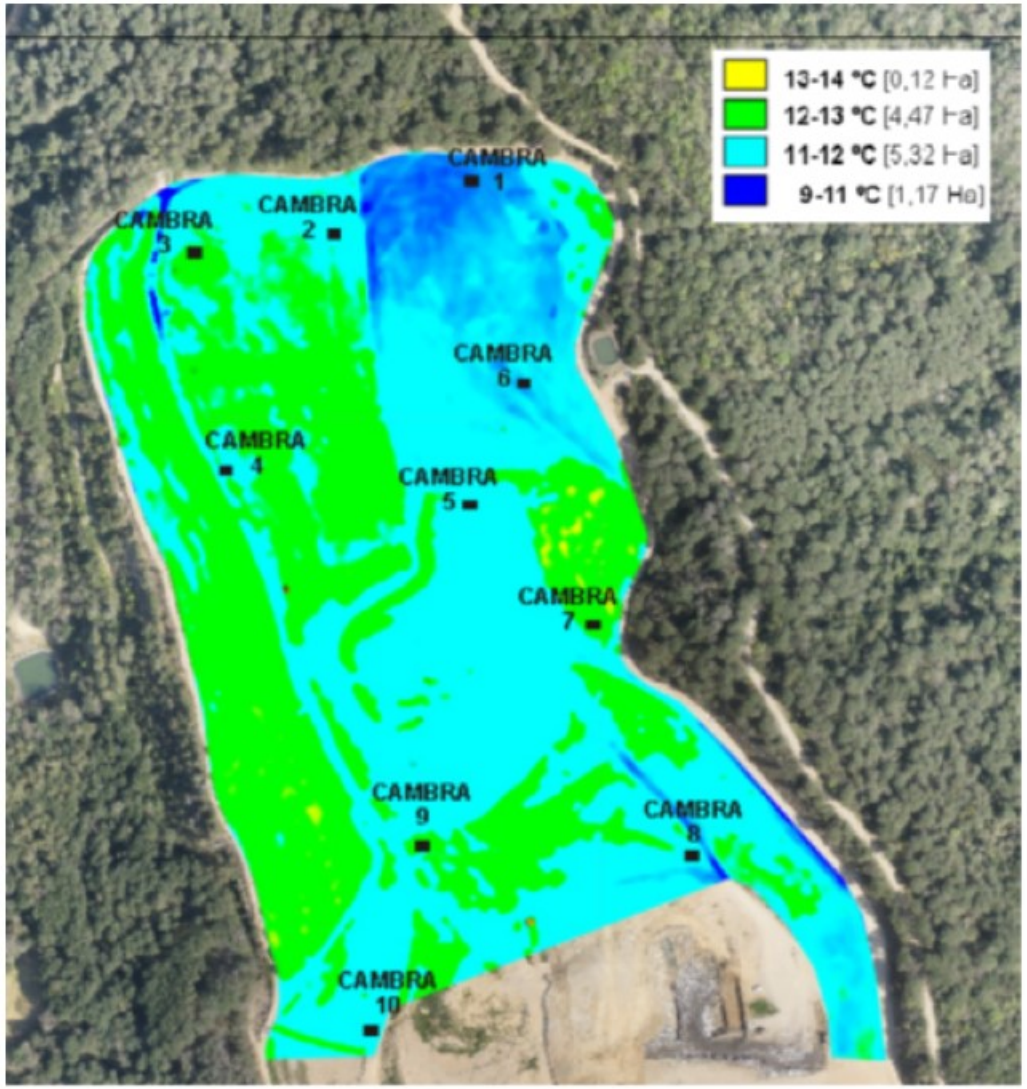
Internal combustion

- ✓ Field tests based on:
  - ✓ CO parameter; Temperature; Other types of studies
- ✓ Technical assessment of the landfill mining





03 OTHER TECHNICAL ASPECTS & LM OPERATION

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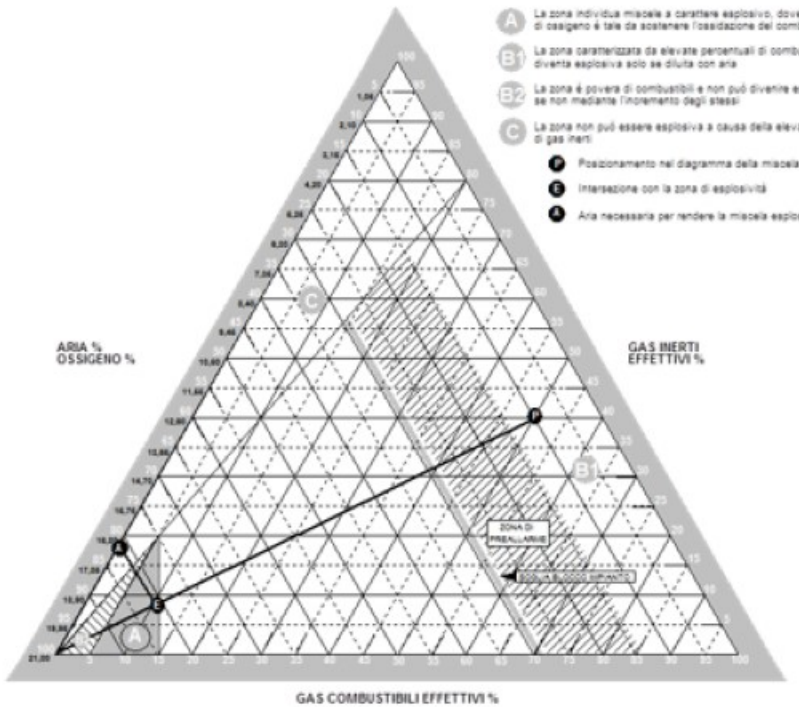
Fire-induced

- ✓ Landfill mining. Excavation plan
- ✓ Spontaneous combustion
- ✓ Combination of concentrations (% methane & oxygen)



03 OTHER TECHNICAL ASPECTS & LM OPERATION

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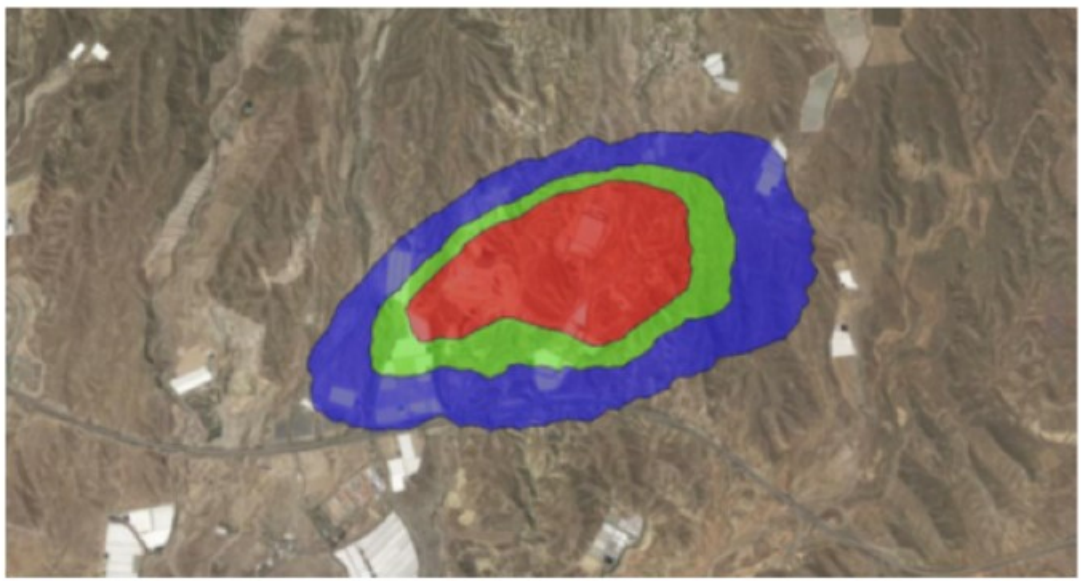
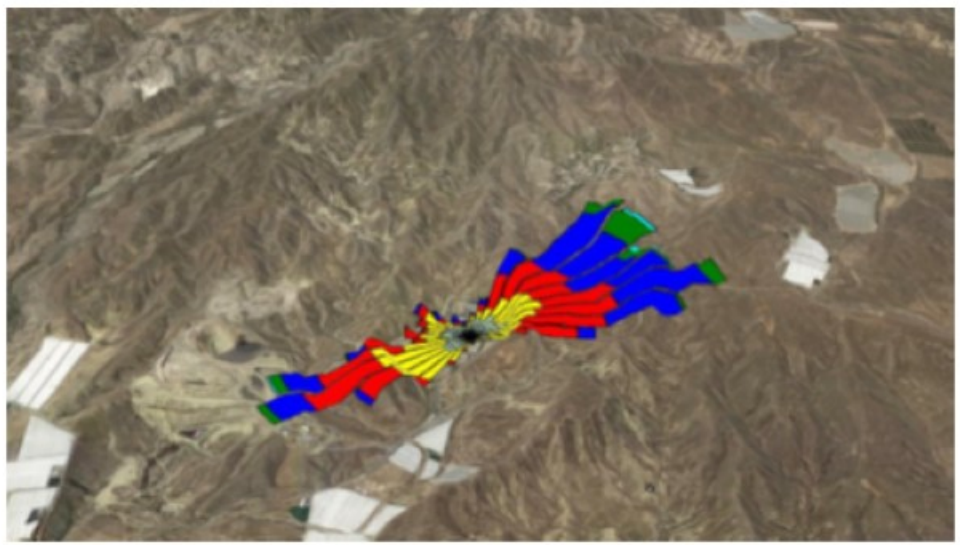
Odour nuisances

- ✓ Sources of odour, odour impact assessment
- ✓ Maintain a minimum open space
- ✓ Implement corrective measures





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Recommendations

04 RECOMMENDATIONS

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- Perform in-situ tests like CPT or Pressuremeter tests to obtain mechanical parameters of waste
- Numerical analysis of excavation and refilling
- Electrical resistivity tomography to evaluate leachate levels
- Field tests for internal combustion
- Odour studies and corrective measures

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THANK YOU FOR YOUR ATTENTION