Find me for questions!

Influence of organic content on viscous compression of soft soils

How differently does peat react to loading in comparison to clay and sand?

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Introduction: What is viscous compression of soils?

When a soil shows viscous behaviour, when vertical pressure is applied, the soil starts to behave similar to a liquid. Essentially, the particles of which the soil matrix is composed start to **reorientate to a more efficient, horizontal position** leading to compression of the soil volume (Fig. 1).

Two important aspects of viscous compression:

1. it occurs under constant effective stress
2. the time dependency (Fig. 2)

Study aim: Examine the relation of specific weight and water content of laboratory samples to geotechnical viscous compression parameters.

Why? -> To improve subsidence modelling by trying to make the secondary compression coefficient dependent.

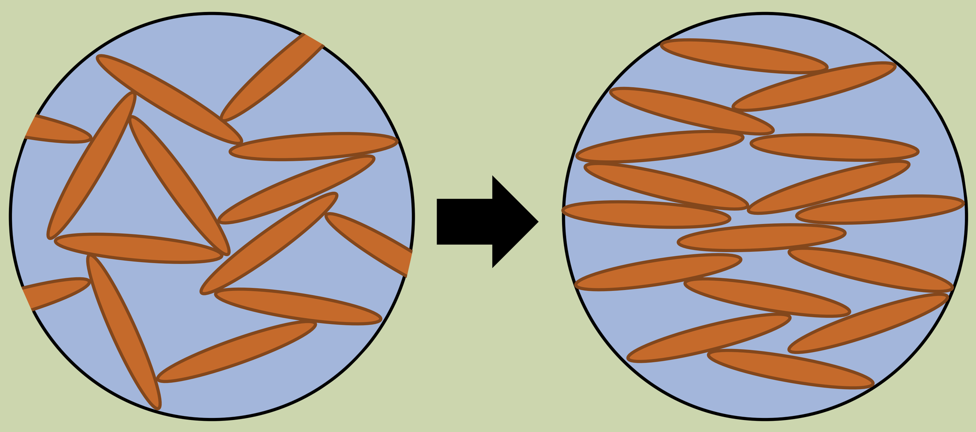


Fig. 1: Schematic view of soil particles reorientating towards a more horizontal position. These ellipsoid shape are only shown to explain the principle. Both clay and peat particles have different, irregular shapes.

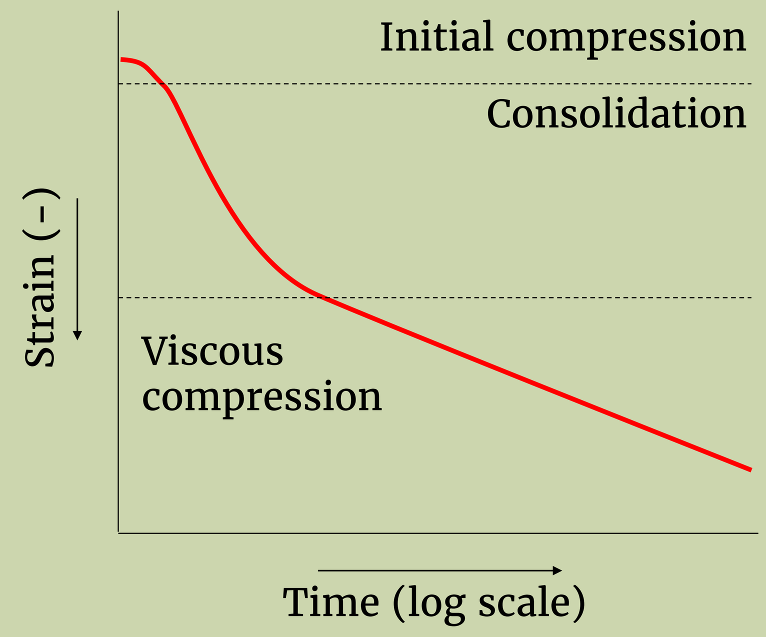


Fig. 2: Schematic graph of soil compression showing the three distinct phases. The viscous compression phase is linear in a semi-log plot

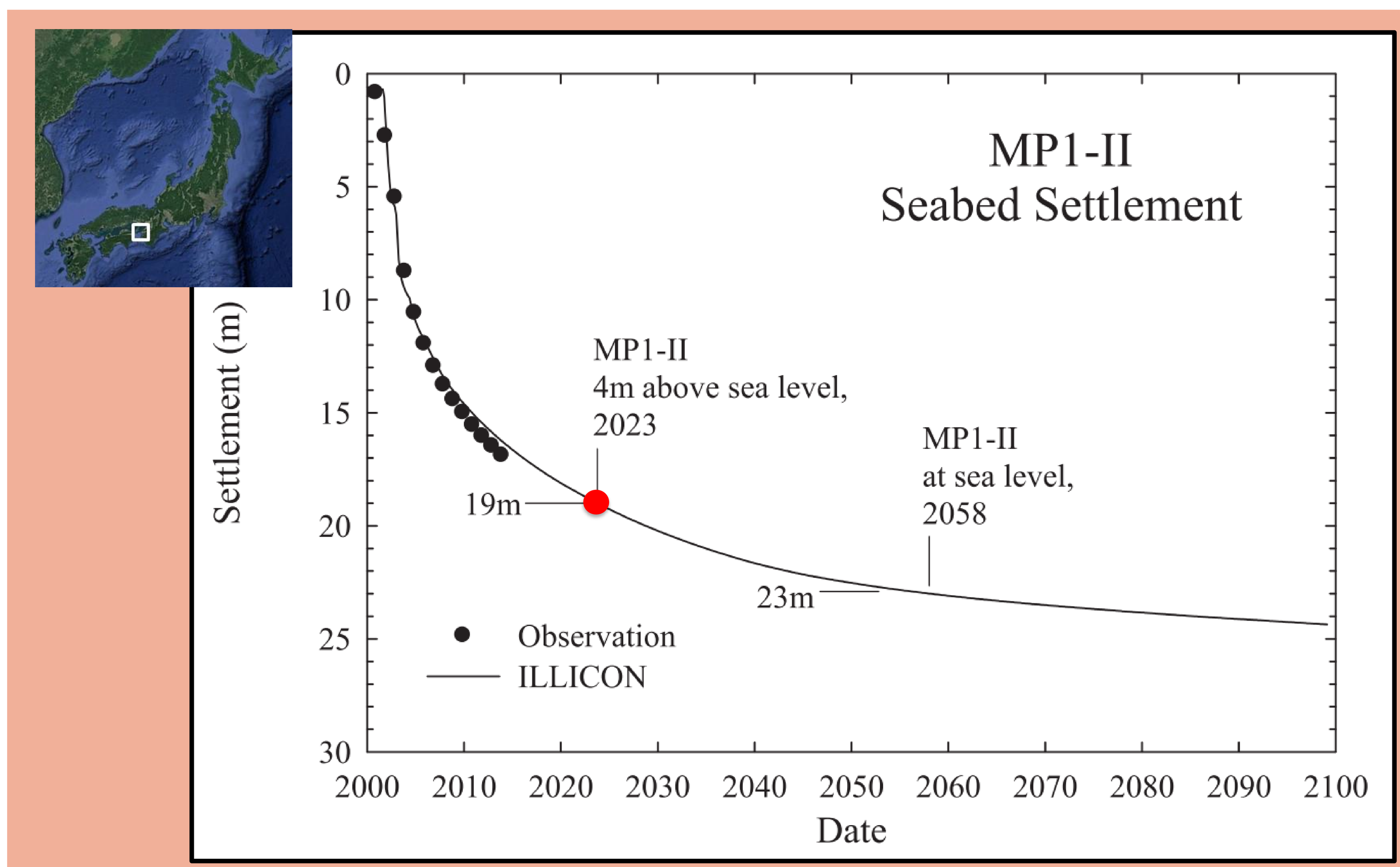


Fig. 2: Measured and computed settlement over time at monitoring point MP1-II on island I of Kansai Airport.[2]

Example: The case of Kansai Airport Islands, Osaka, Japan

Kansai Airport is located on artificial islands that exceed subsidence expectations.

Original situation:

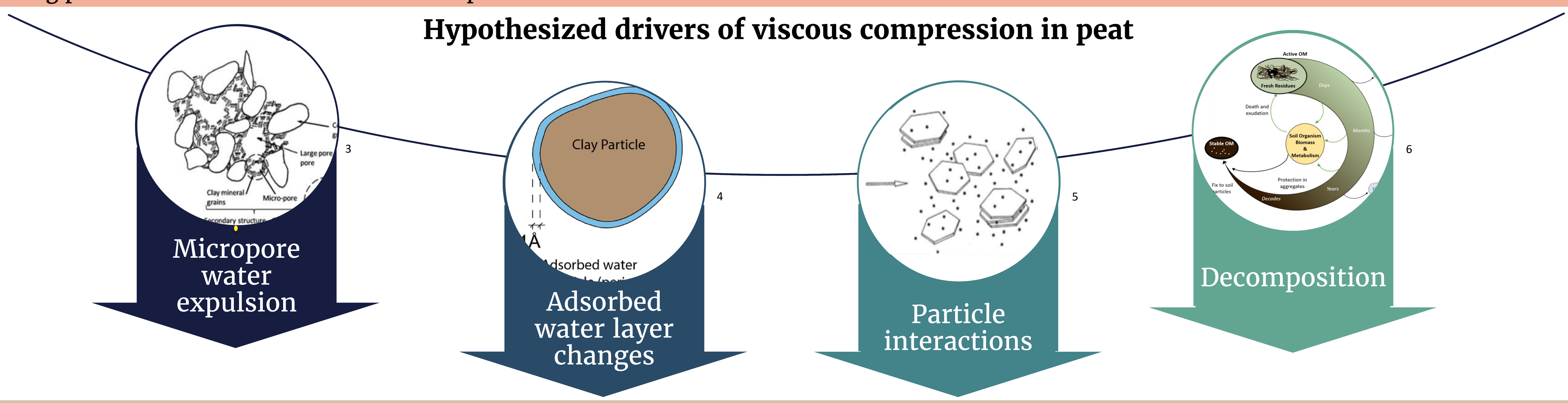
- Started in 1994 by draining the original seabed level at 18-20 m below MSL
- Drilled to ~400 m depth in unconsolidated subsurface
  -> clay layers have a **combined thickness of 290 meter**
- Construction and preloading with 36.7 m sand fill
- Elevation goal to stay above minimum safety elevation of 4 m above MSL

Simplified model prediction -> incorrect prediction

Consequences:

- Minimum safety elevation reached in 2023 for Island I (Fig. 2) and in 2036 for Island II
- In 2100, predicted total **subsidence in the range of 17-25 m** for both islands
  -> newly calculated viscous compression of 4.60 m
- Additional costs for the construction due to subsidence of **$12 billion in 2008**

Hypothesized drivers of viscous compression in peat



Preliminary results: Soil strength parameters

Methodology:

- 349 peat samples and 63 clay samples collected
- Standard incremental oedometer test or CRS test to determine i.e., the **secondary compression coefficient (C_α)** or abc-isotache **c parameter**
- Determined additional sample characteristics: wet/dry weight, water content & void ratio

Results:

- Clay samples consistently **better correlation** for the different parameters and ratios
- Peat samples especially **large variation in reported C_α and c values** (Fig. 3).

Outcomes:

- **Continuous trend/relation** for both the clay and peat samples?
  -> **Not likely**, thus different behaviour
- Suggestions: trend up to certain boundary &
  link water content to loss on ignition

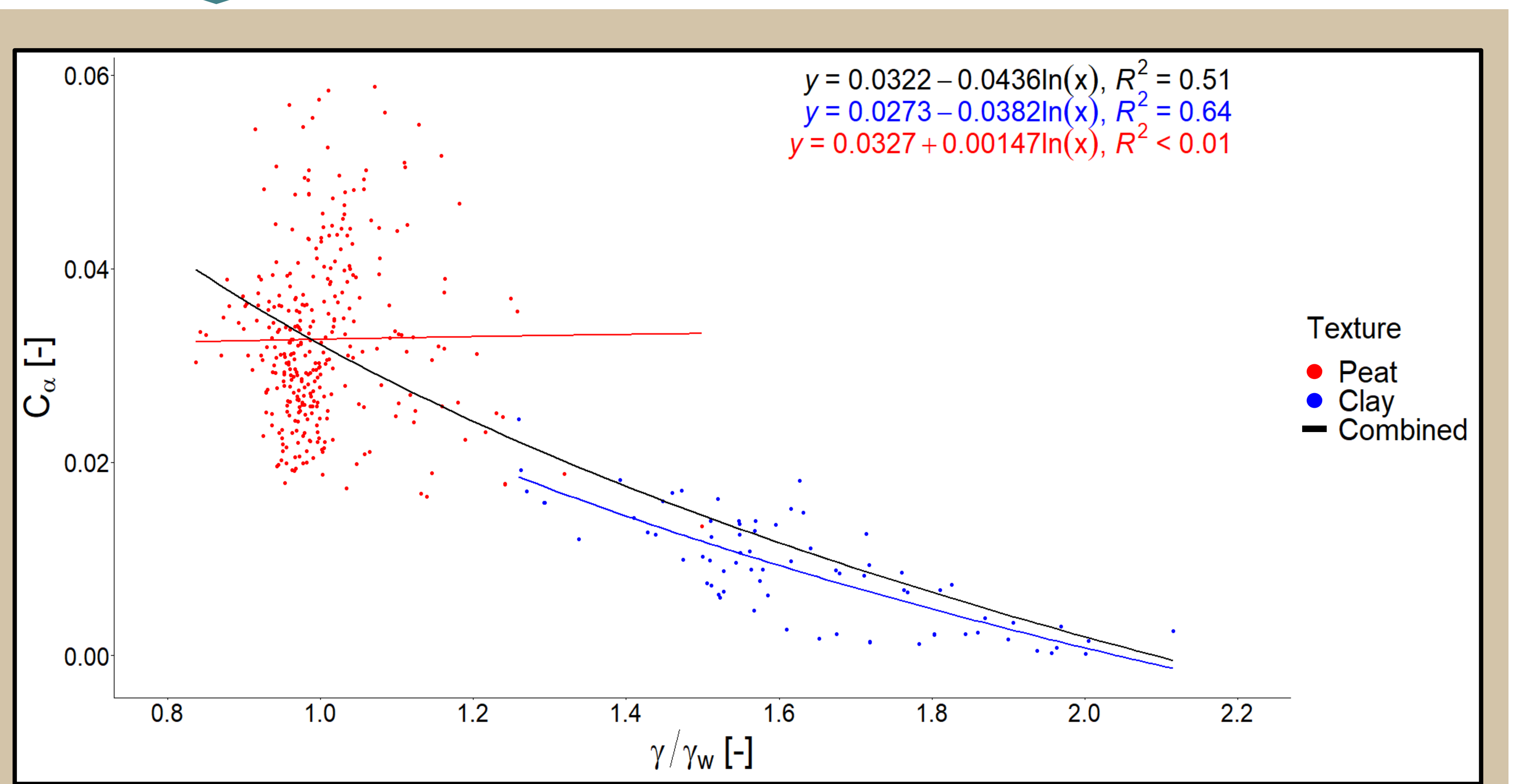


Fig. 3: Secondary compression coefficient (C_α) for varying relative weight of the soil sample (γ/γ_{dr}). The data has been grouped based on the reported main lithological class (van Elderen et al., in prep).

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The information has been carefully collected, but should not be interpreted differently than presented here.

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