



Compression Behavior of Municipal Solid Waste



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Motivation and Objectives

- Landfills are typical end-state of municipal solid waste (MSW) in North America
- Sustainable land practice = maximizing amount of waste managed in a given landfill
- Bioreactor landfills can *enhance* waste degradation and stabilization, *increase* waste settlement, *treat* leachate in situ, and *reduce* post-closure monitoring
- Predicting MSW settlement is important for vertically expanding existing landfills and operating bioreactors

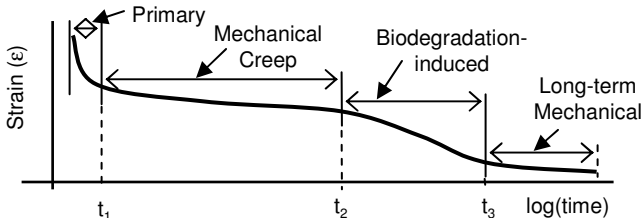
Objective: Increase accuracy and reliability of MSW settlement predictions by enhancing the understanding of MSW compression behavior and parameterizing conventional settlement models

Hypotheses

- 1) Laboratory-scale tests can be used to assess field-scale MSW compression behavior
- 2) Laboratory compression testing is scale dependent
- 3) Secondary compression behavior depends on the state of MSW degradation

Background

- MSW settlement occurs through **physical** yielding of constituents and **biological** degradation of the solid organic fraction
- Anaerobic biodegradation is a microbial driven process yielding CO₂ and CH₄ as end-products
- MSW settlement occurs in series of sequential phases
 - Primary – physical response to stress increase
 - Mechanical Creep – physical yielding and reorientation of constituents
 - Biodegradation-Induced – creep combined with degradation of solid organics



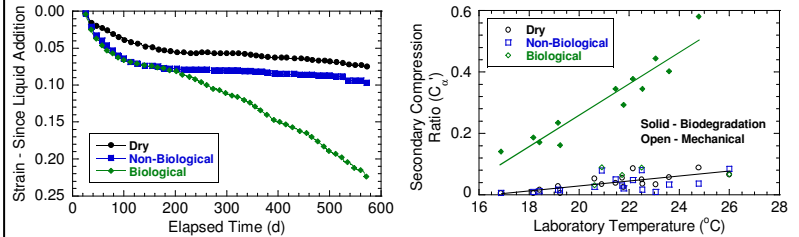
- MSW settlement estimations with four types of models:
 - Soil-mechanics – most commonly used in practice
 - Rheological – couples stress and time
 - Empirical – typically fit to existing data sets
 - Biodegradation – first-order degradation kinetics

Acknowledgements

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Preliminary Laboratory Compression Testing

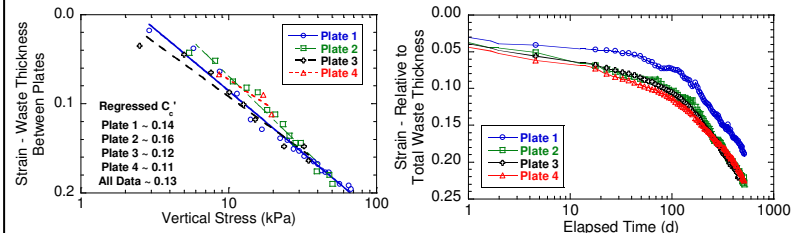
- Three operational conditions: (1) dry – no liquid addition, (2) non-biological – liquid addition spiked with biocide, and (3) biological – leachate recirculation



- Observations: (1) Liquid addition to MSW induced compression through moisture induced softening and solids decomposition, (2) temperature affects rate of mechanical creep and biodegradation-induced compression, (3) presence of CH₄, stabilization of pH, and reduction in chemical oxygen demand are indicators of biodegradation-induced compression

Field-Scale Lysimeter

- Assess hydraulic and compression properties of MSW for conditions representative of full-scale landfills
- Lysimeter: 8-m-tall and 2.4-m-diameter steel cylinder; constructed in waste mass to maintain typical temperatures. Waste: 8.3 kN/m³ and 33% water content
- Four settlement plates spaced vertically, Plate 4 at top



- Observations: (1) individual waste lifts have similar primary compression behavior and (2) waste under varying vertical stress shows similar time-dependent compression behavior when total waste thickness accounted for

Future Work

- Laboratory experiments in large-scale (300-mm-diameter) and small-scale (62 and 100-mm-diameter) cells to assess effects of composition and material shredding, and state of MSW degradation of compression behavior
- Simulate laboratory data sets with conventional settlement models and assess the influence of material and operational conditions of model parameters

