

# Designing urban deep basements in South East England for future ground movement

Progress and opportunities for experimental simulation of long-term heave

Deryck Chan (dykc3@cam.ac.uk) | Co-author: Prof. **Gopal Madabhushi**

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# Imagine...

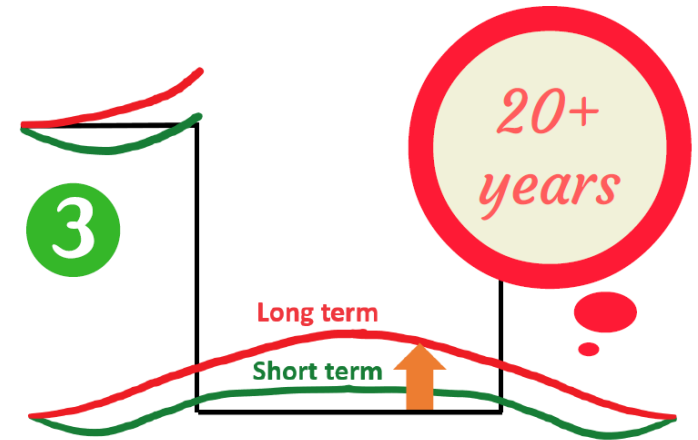
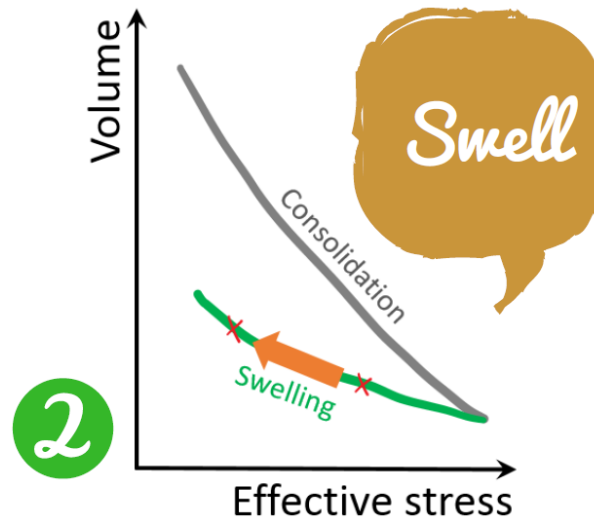
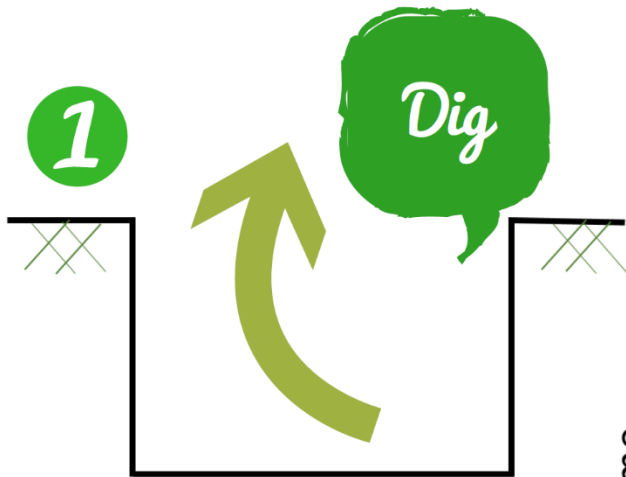


Liverpool Street Station site, London, 2016

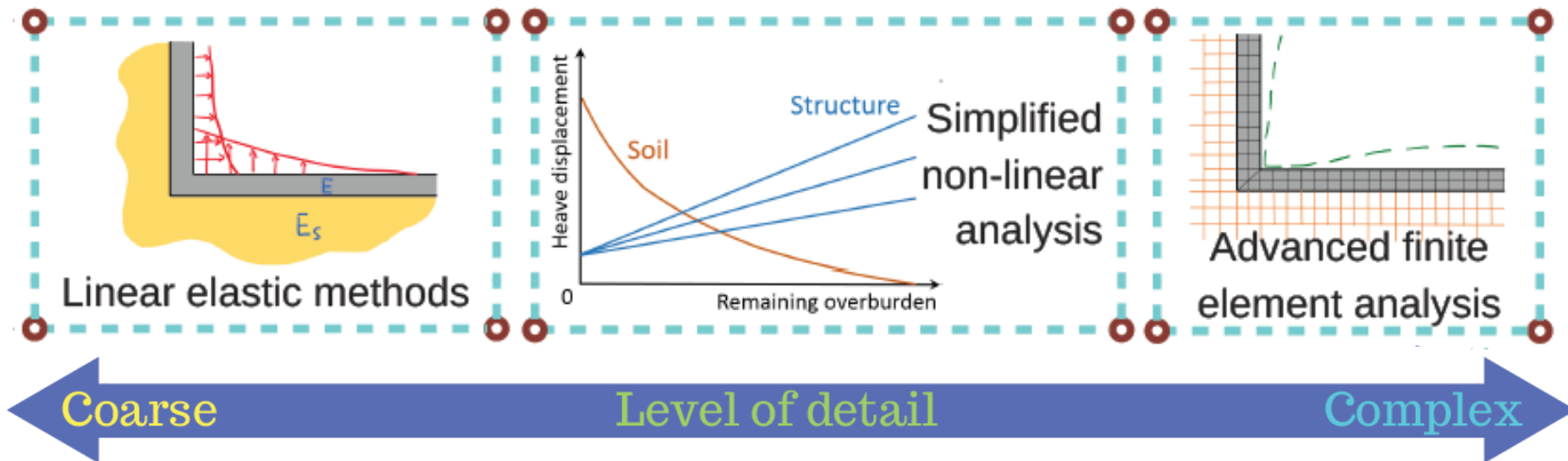
# Outline

- Cause of basement heave
- Current design methods
- Case histories
- Experimental modelling

# Causes of heave

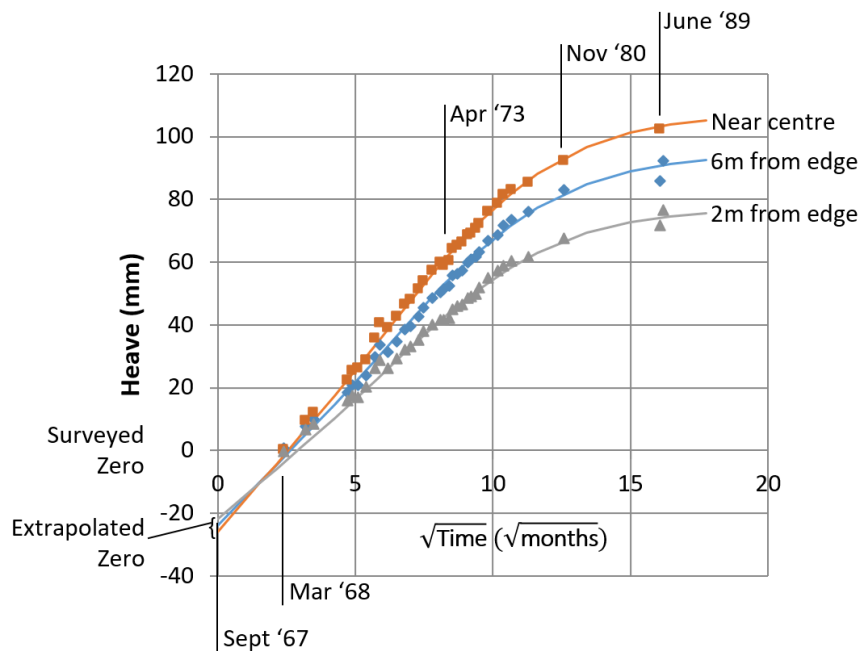


# Current design methods



...but how do we know if we are right?

# Case studies



- Horseferry Road, London (left)
- Other prominent cases:
  - British Library, London
  - Lion Yard, Cambridge
  - Shell Centre, London

# Research gap

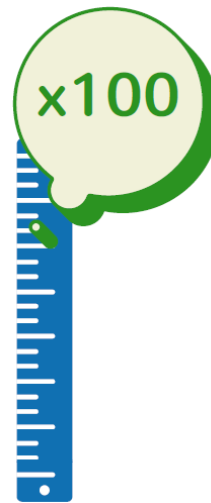
- Site data are hard to obtain
- Even when available, they are spot-checks rather than controlled experiments
- We need experimental simulations
  - Quantify the effect of structural stiffness upon long-term heave pressure and displacement

# Geotechnical centrifuge simulations

- In the context of simulating heave movements of deep basements:



Simulation at 100x  
earth's gravity



20m railway station box  
becomes 200mm model

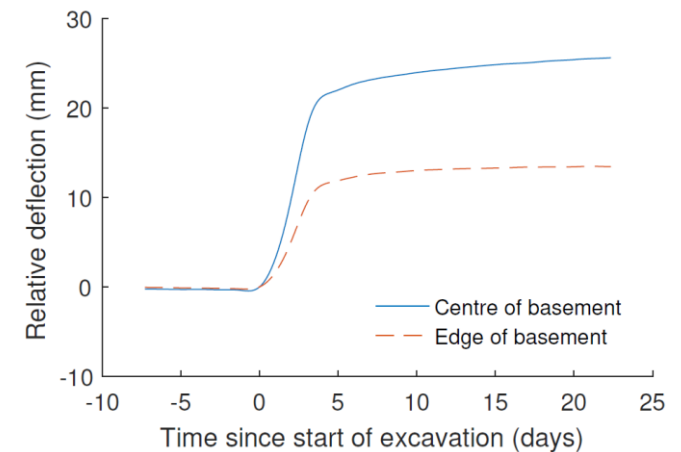
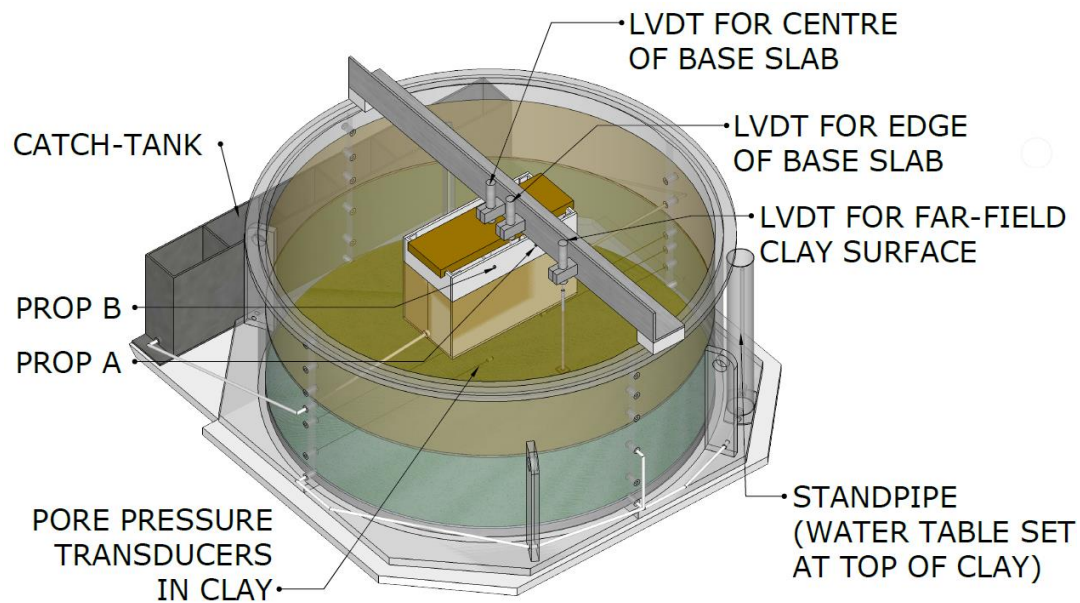


5 years of real-life  
movements in 5 hours

- Plus the benefits of extensive soil and structure monitoring



# Centrifuge model



# Urbanisation



# Summary

- Urbanisation is generating demand for large, deep basements
- South East England is a prime example
- Long-term heave movements are inevitable
- Current design methods need refinement by experimental data
- Centrifuge modelling permits simulation in laboratory time-scale