



COMMISSION OF THE EUROPEAN COMMUNITIES
FP7- INFRASTRUCTURES-2008-1
SP4-Capacities



S E R I E S

SEISMIC ENGINEERING RESEARCH INFRASTRUCTURES
FOR EUROPEAN SYNERGIES

SERIES Workshop

February 2012 - Istanbul

Susceptibility of Shallow Foundations to Rocking and Sliding Movements during Seismic Loading

C.M. Heron, S.K. Haigh & S.P.G. Madabhushi
University of Cambridge, UK (UCAM)

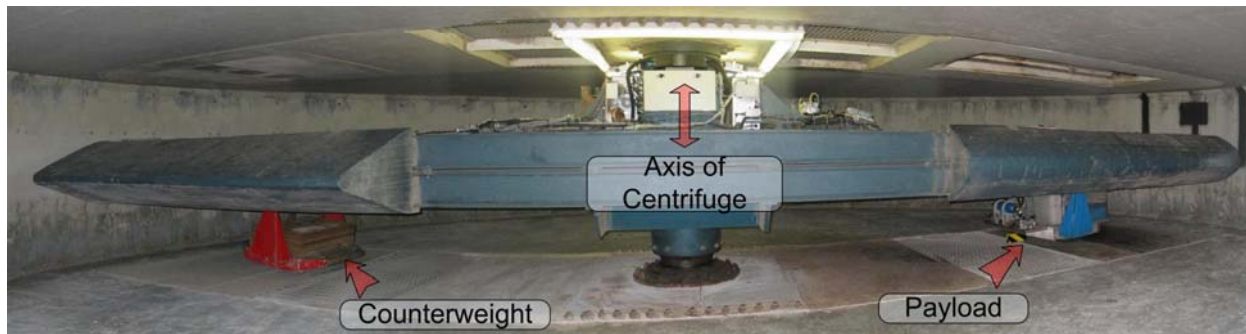
Research funded by EU FP7 SERIES project

JRA 3.2 – Dynamic Soil Structure Interaction:
Centrifuge Testing

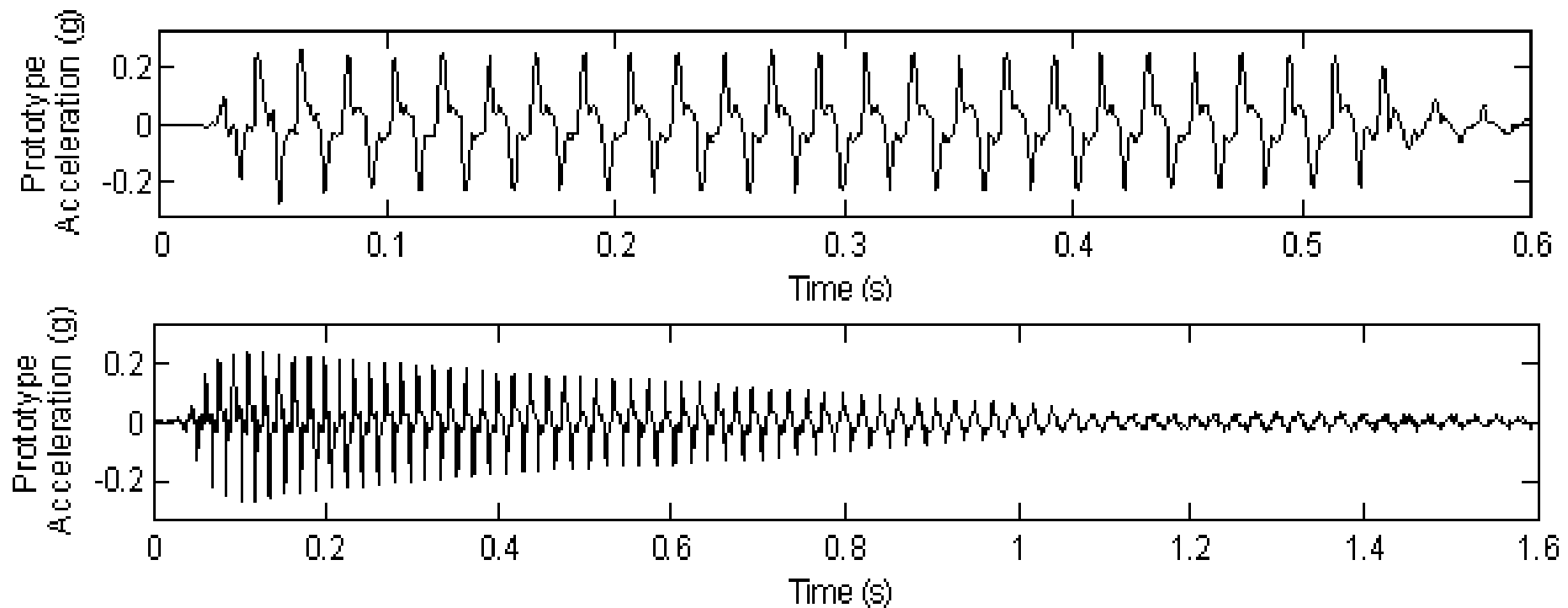
Complimentary research is also being carried out
by IFFSTAR (LCPC), France

Testing Facilities

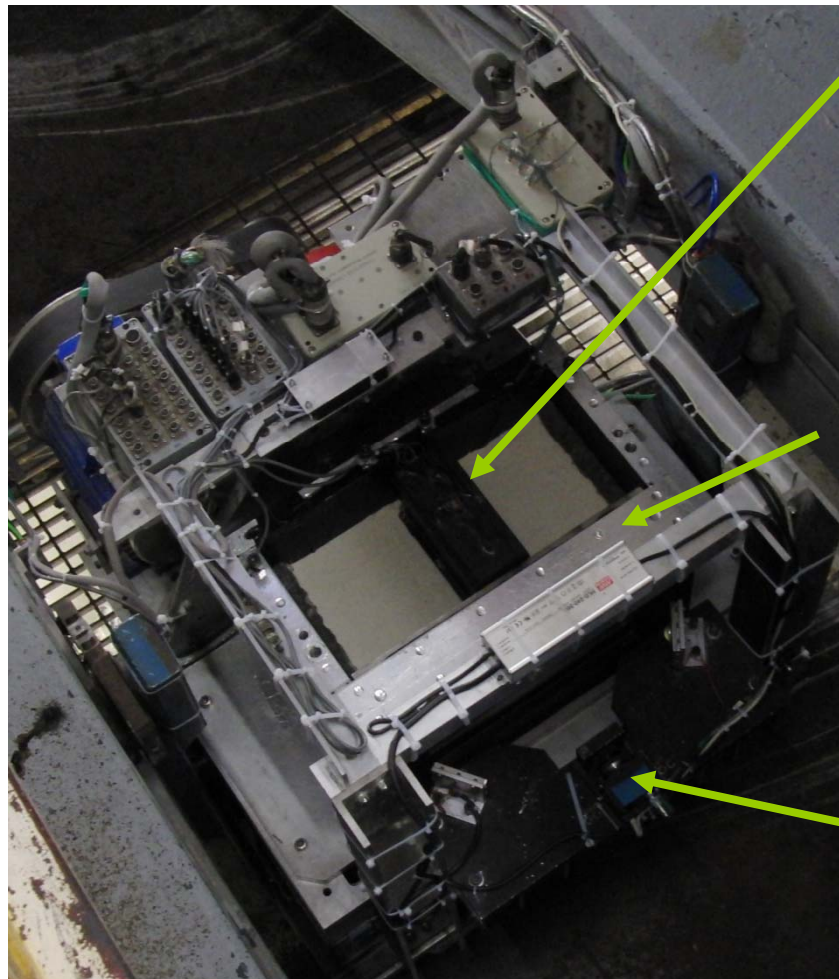
- Turner Beam Centrifuge
 - 10 metre diameter
 - 150 g-ton capacity (operated at 50g for these tests)
- Stored angular momentum (SAM) Actuator
 - Fixed frequency, fixed magnitude
 - Decreasing frequency, decreasing magnitude



Example Input Traces



Centrifuge Model Setup



Model Structure

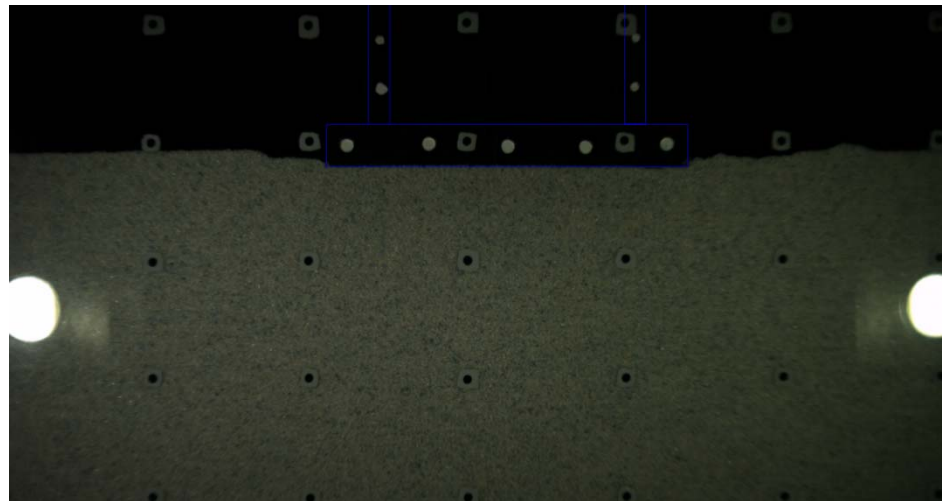
Window Sided
Model Container

High Speed Camera



Particle Image Velocimetry (PIV)

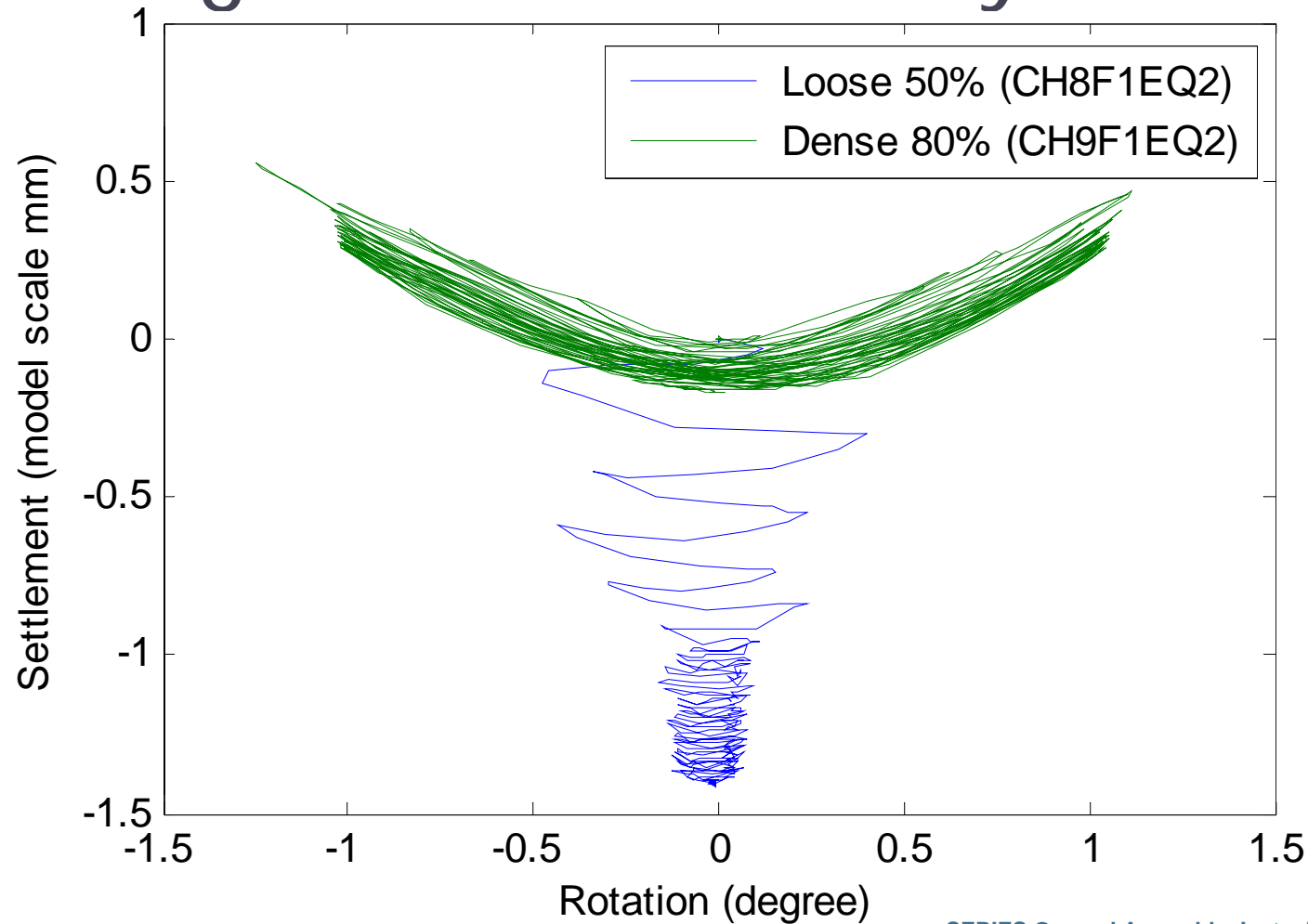
- Track patches within an image
 - Displacement vectors for soil movement below structure
 - Structural movements: co-seismic rotations and settlements



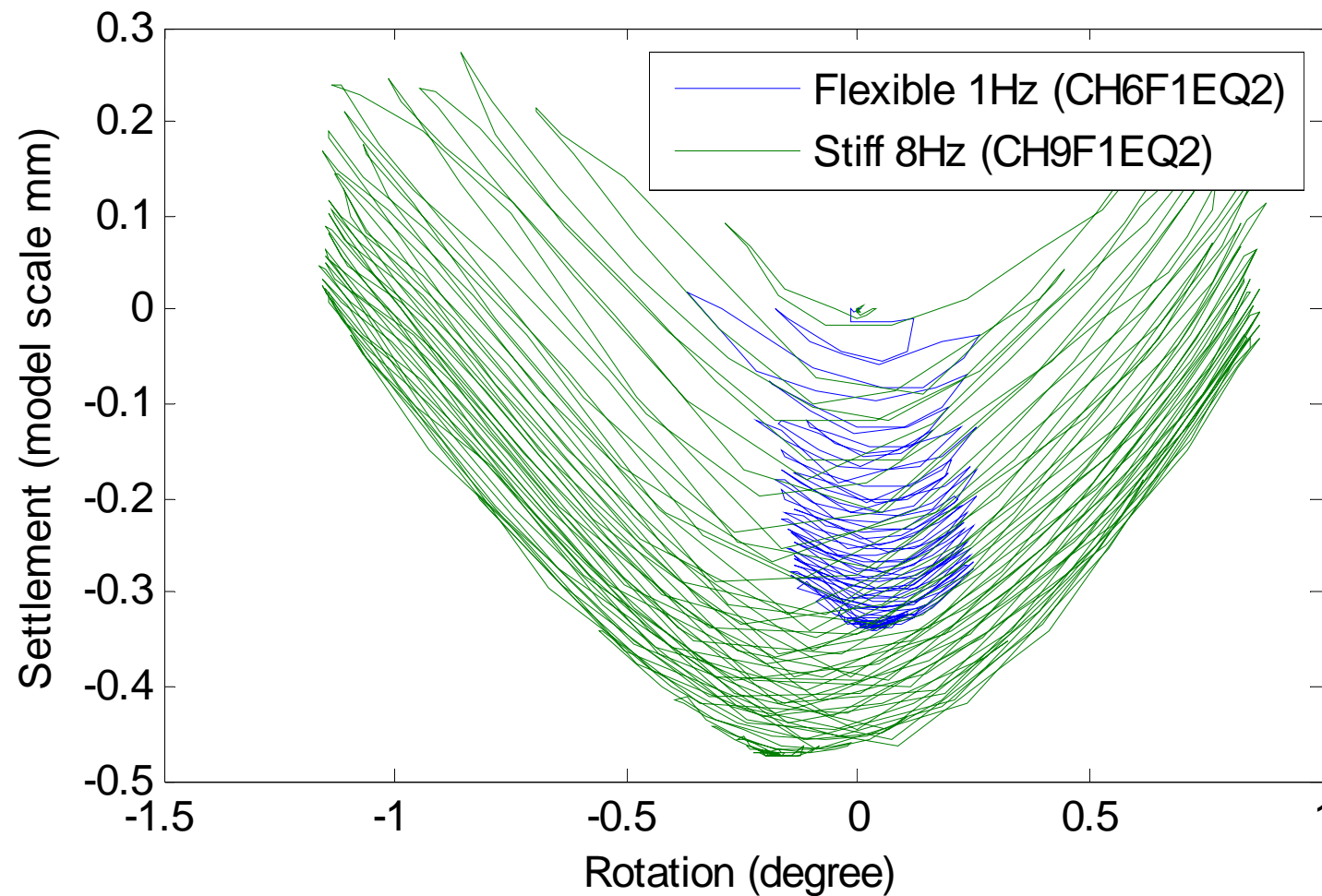
Rocking of the Foundation

- Rocking occurred in all tests
 - Rotation & lift-off depends on
 - Soil Density
 - Structural Stiffness
 - Height of Centre of Gravity

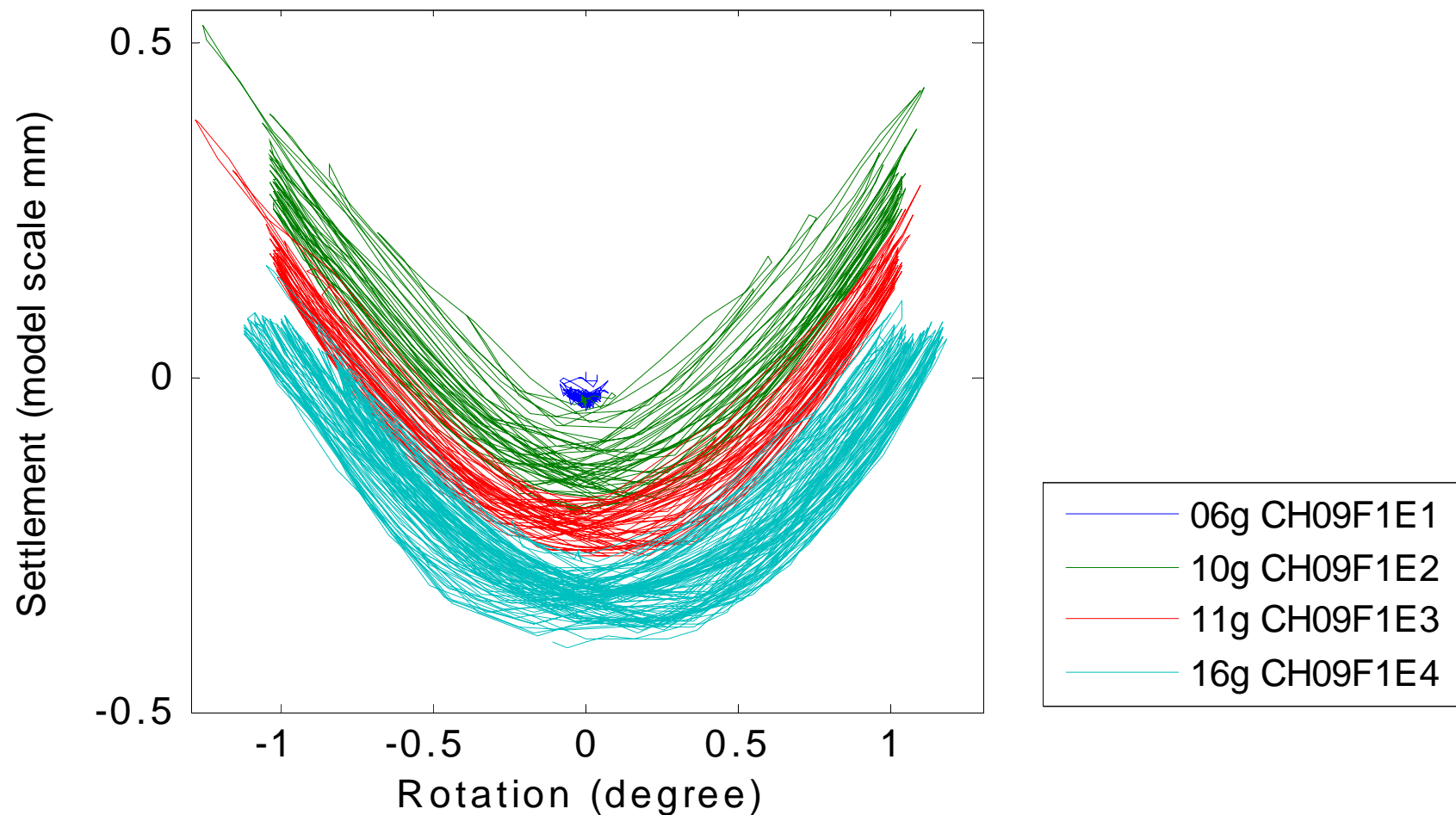
Rocking: Relative Density Effects

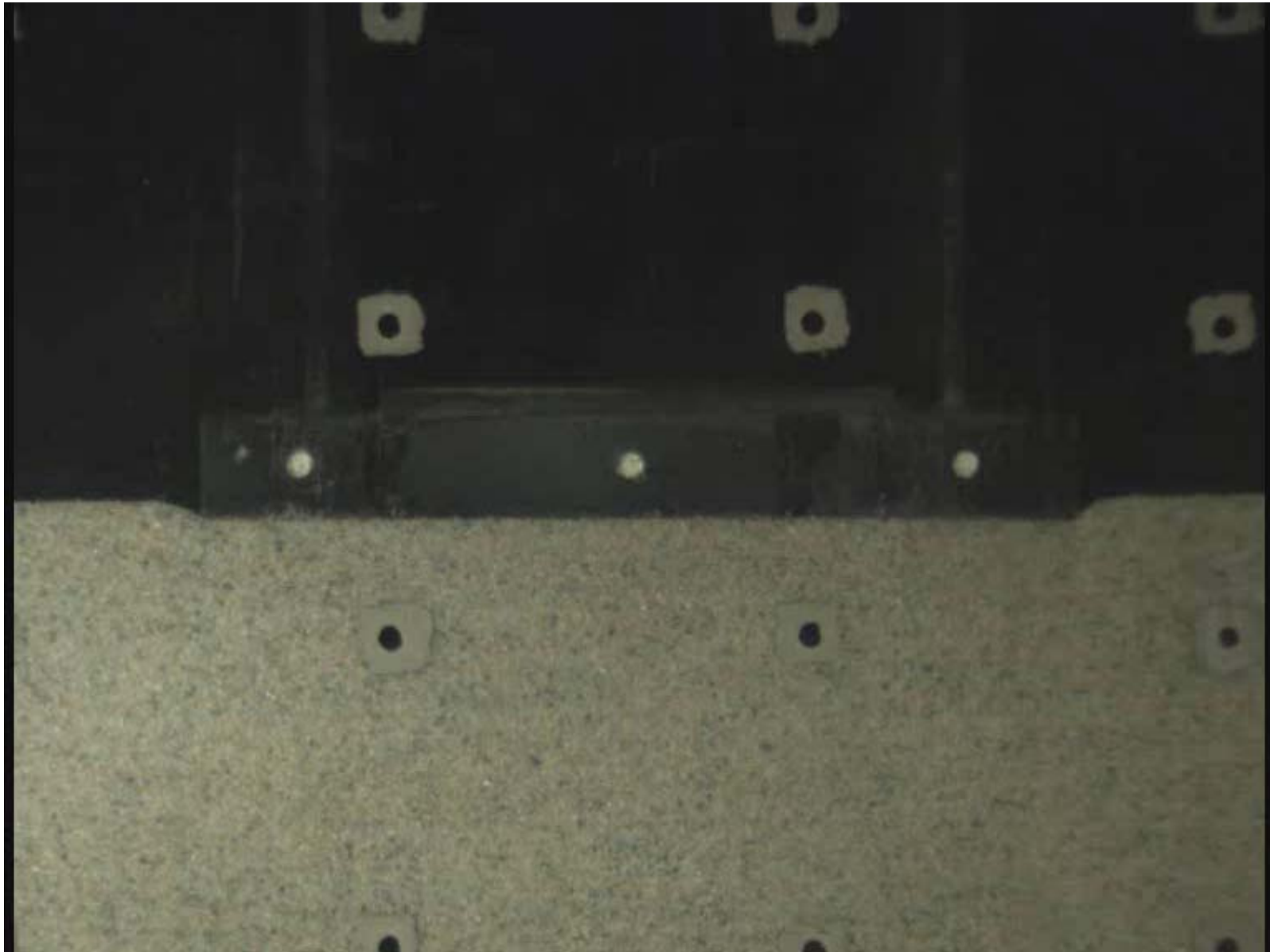


Rocking: Structural Stiffness Effects



Rocking - Successive Earthquakes



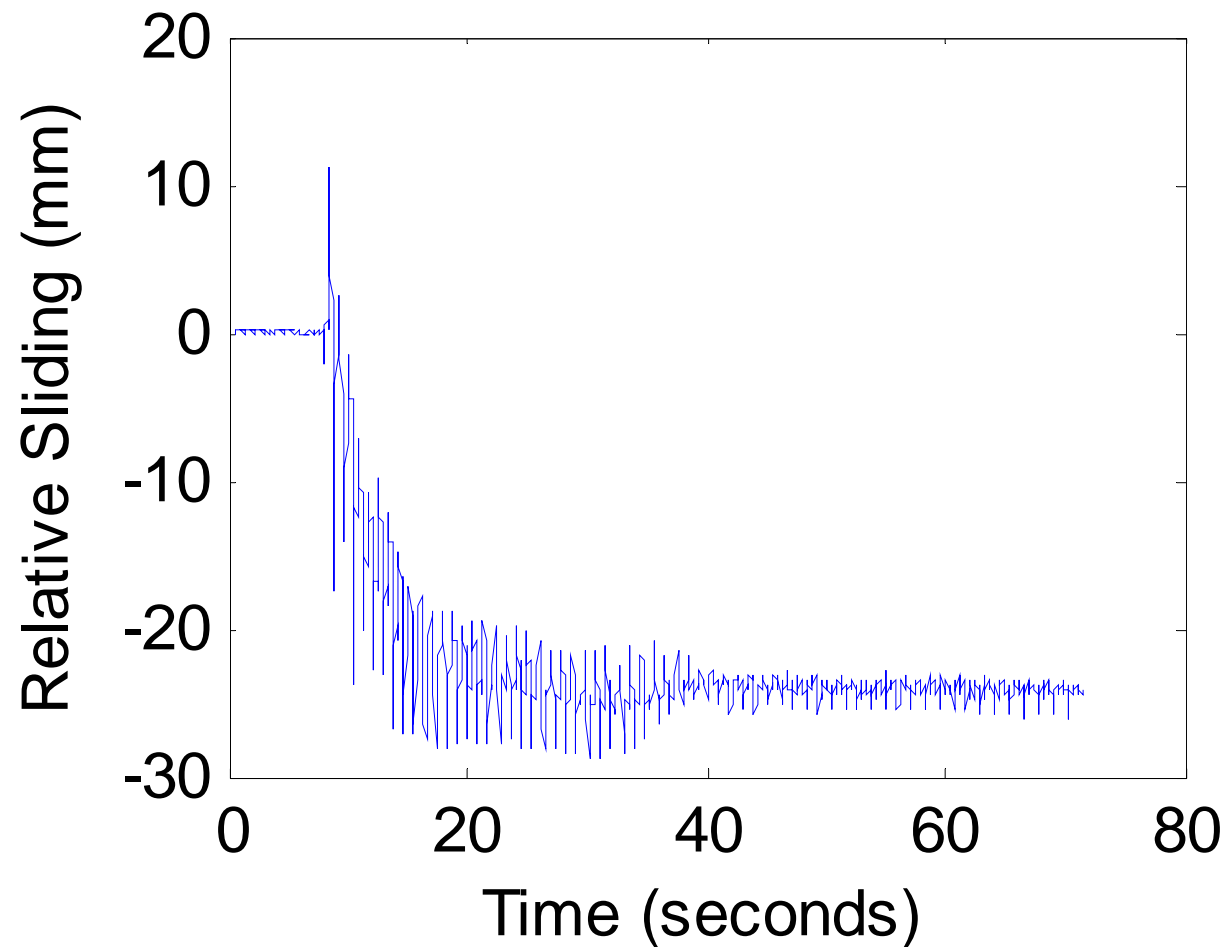


Sliding of the Foundation

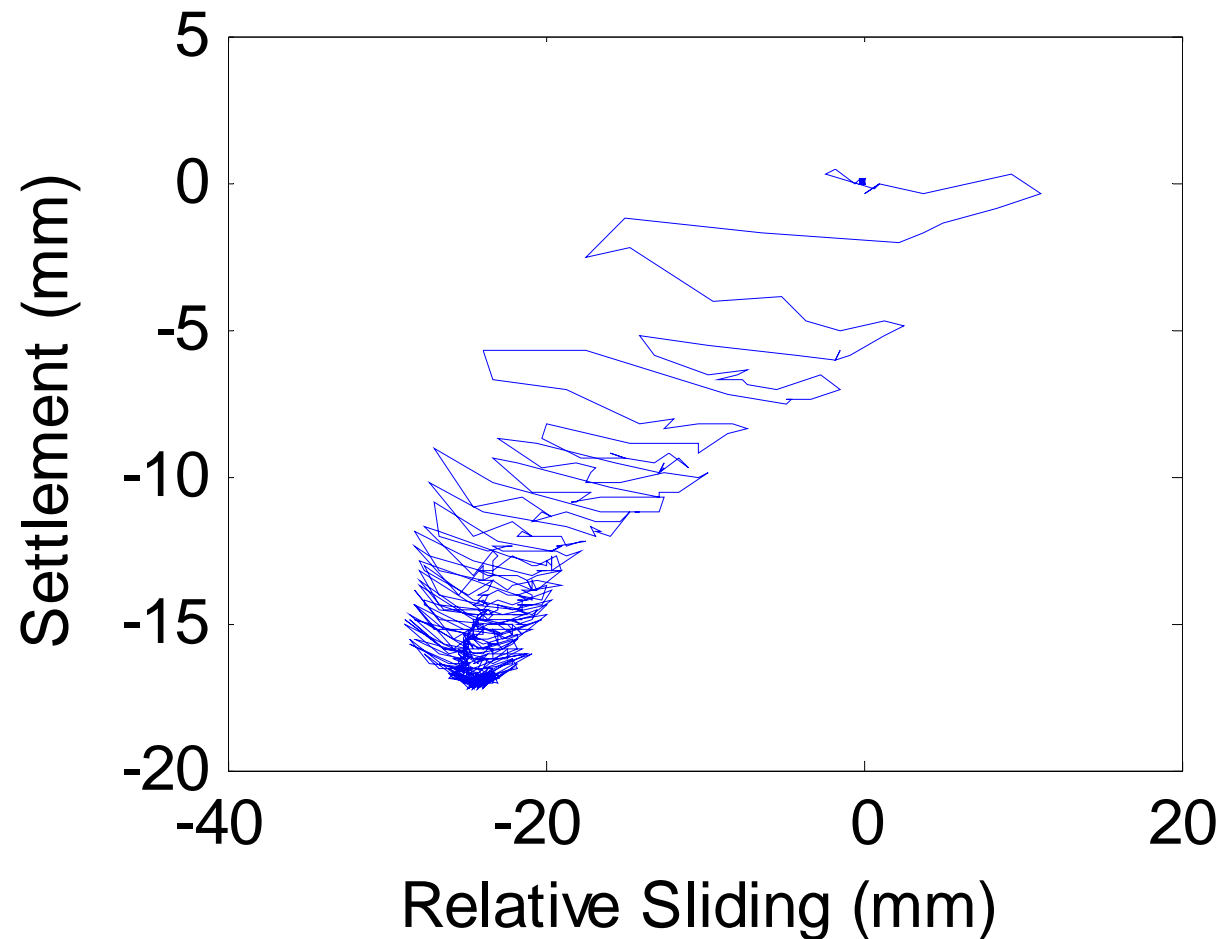
- No sliding with high C.o.G structures
- Sliding observed with simple, single mass strip
- Permanent relative movement accumulated
 - Due to non-symmetrical nature of input traces



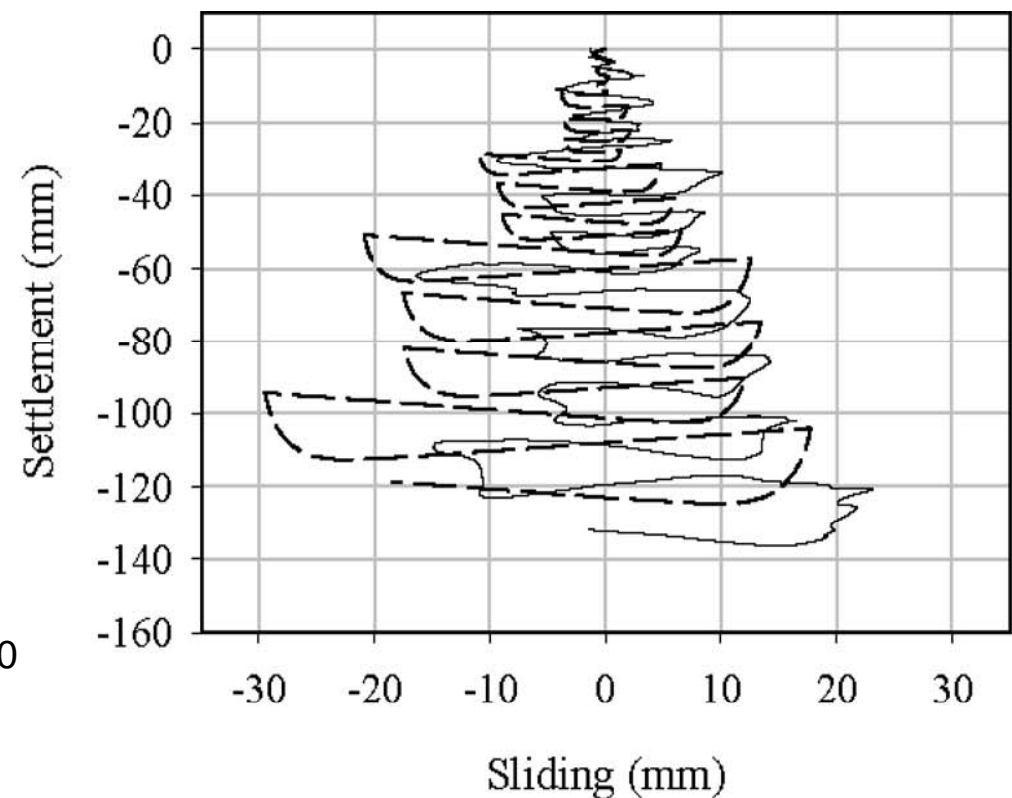
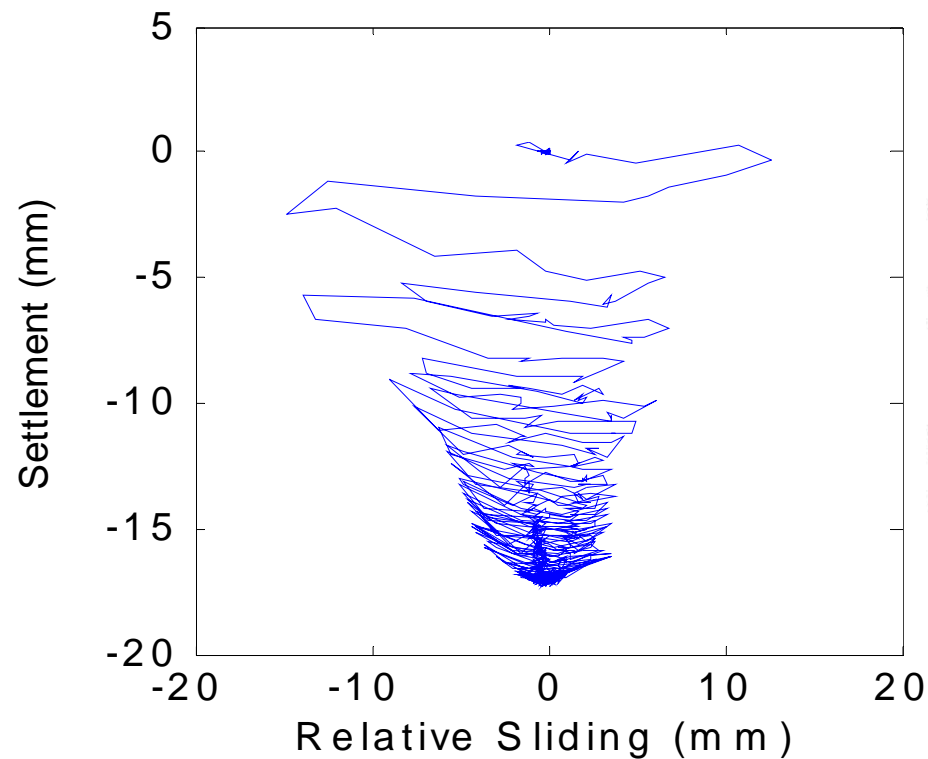
Sliding - Time Trace



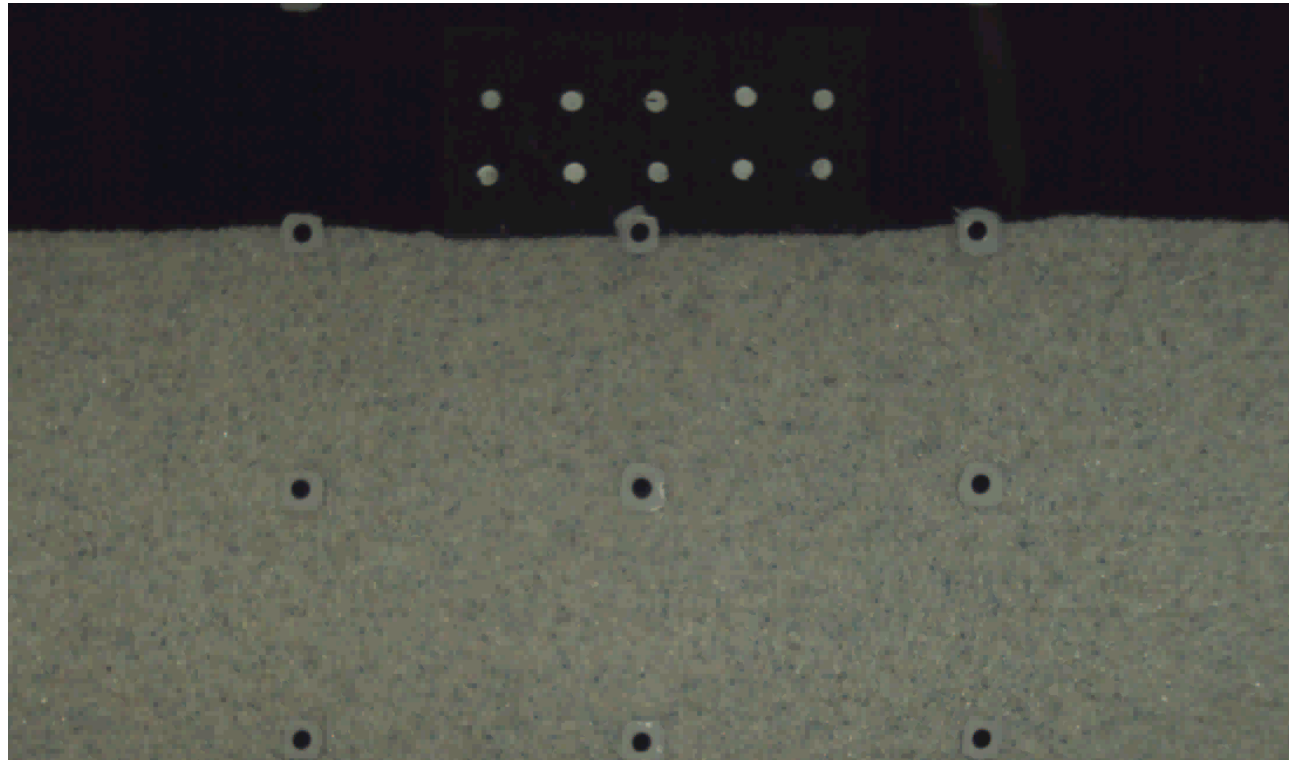
Sliding - Settlement Trace



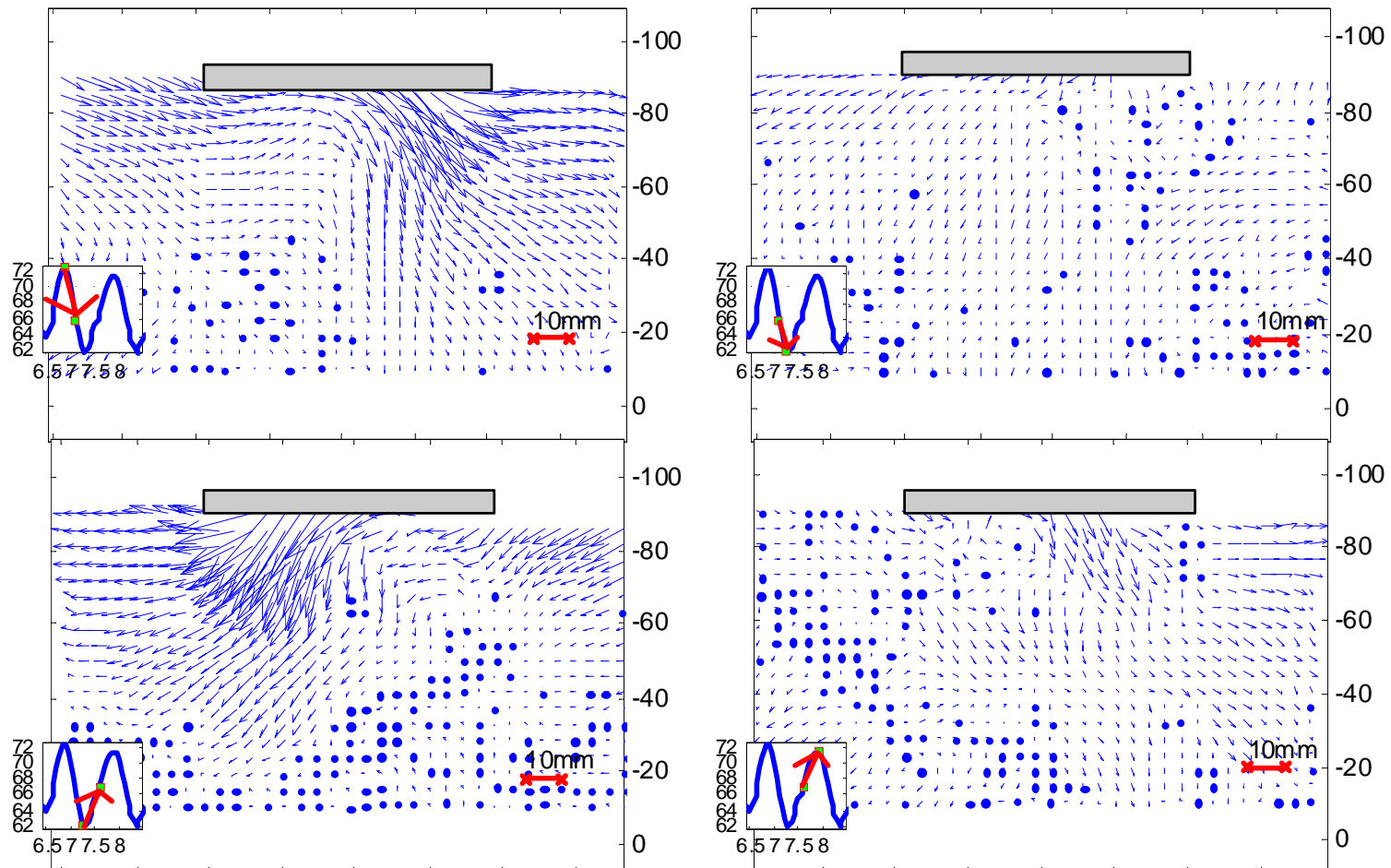
Sliding - Literature Comparison



S.A. Gajan and B.L. Kutter. Contact interface model for shallow foundations subjected to combined cyclic loading. *Journal of Geotechnical and Geoenvironmental Engineering*, 135(3):407–419, 2009.



Soil Deformations



Summary

- Still more analysis required, however:
 - Understanding of rocking and sliding behaviour
 - Comparison to literature
 - Validated model can be proposed

Thank you

Charles Heron: cmh78@cam.ac.uk