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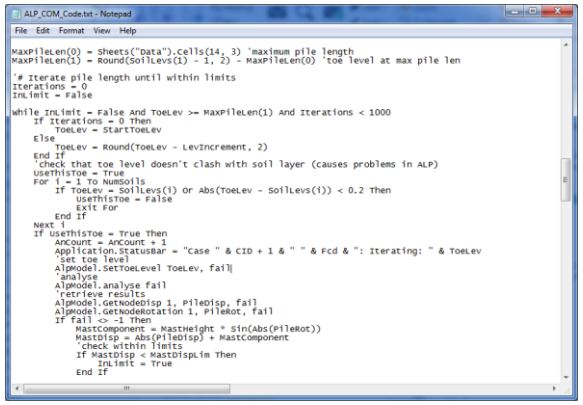
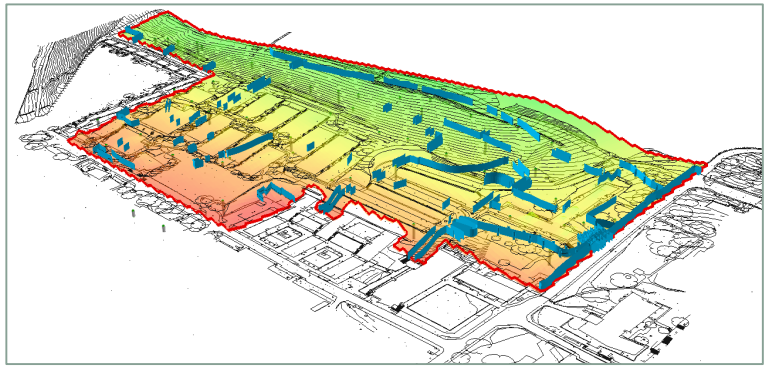


Geotechnical Analysis

Automation in Geotechnics
Case Studies and Future Innovation



Zeena Farook

Application Specialist and Geotechnical Engineer

Discuss

ARUP

1. Drive for Automation in Geotechnics

2. Case Study Examples

3. Opportunities and challenges from Automation

4. How to find out more

Authors

ARUP

- Mark Skinner – Senior Geotechnical Engineer, Arup
- Matthew Brown – Senior Geotechnical Engineer, Arup
- Carol Matthews – Associate, Arup and Lead Geotechnical Developer, Oasys
- Zeena Farook

Oasys Customers

Universities using Oasys

Why Automate?

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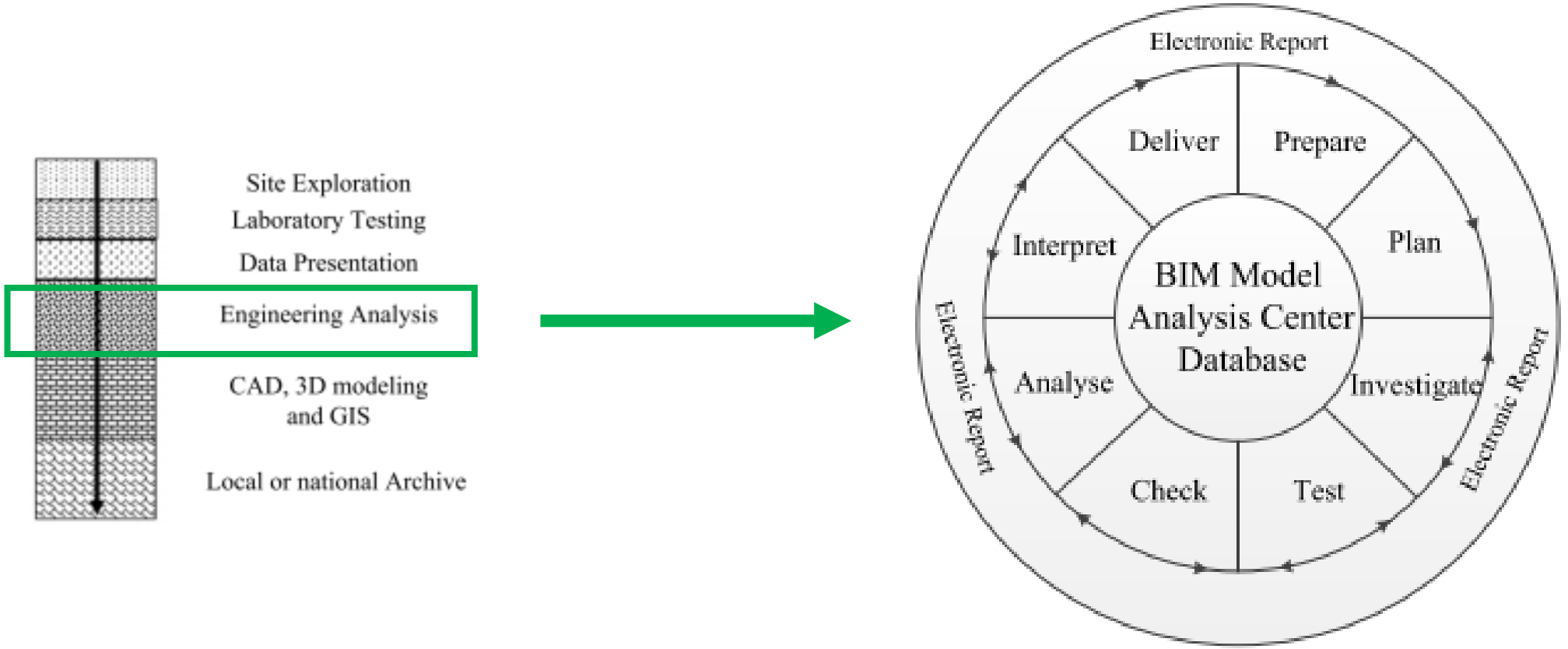


Figures for concept illustration from Zhang et al (2016), The Workflow and Operational Model for Geotechnical Investigation based on BIM, IEEE Open Access Journal

How do we Automate?

ARUP

- Allow external programs to pass information and instructions to and from each other

- Use COM (Component Object Model).
  Can use Excel (VBA), MATLAB and Python

Where can we Automate?

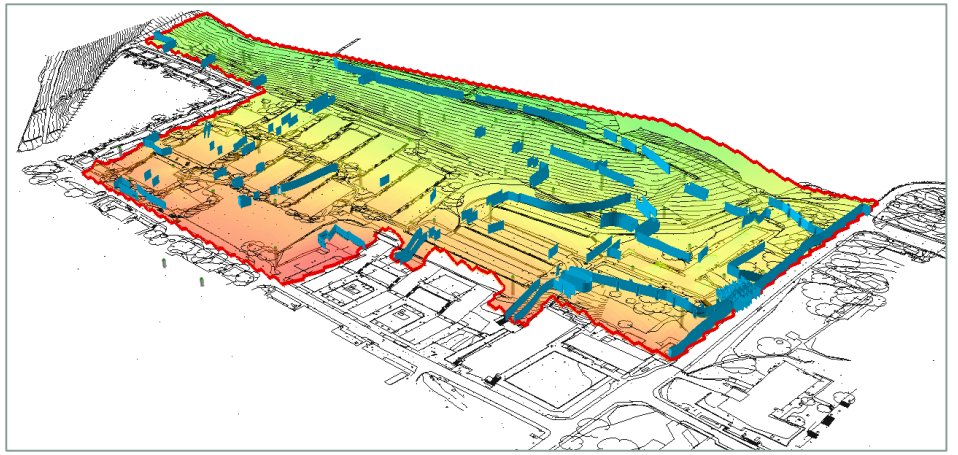
ARUP

- Input
  - Import of data from various other sources
    - Geometry from GIS or CAD
    - SI data from AGS format ? What about interpretation?
    - Instrumentation data
- Analysis
  - Sensitivity analyses / iteration / optimisation
  - Back-analysis
- Output
  - Export for post-processing
  - Databases

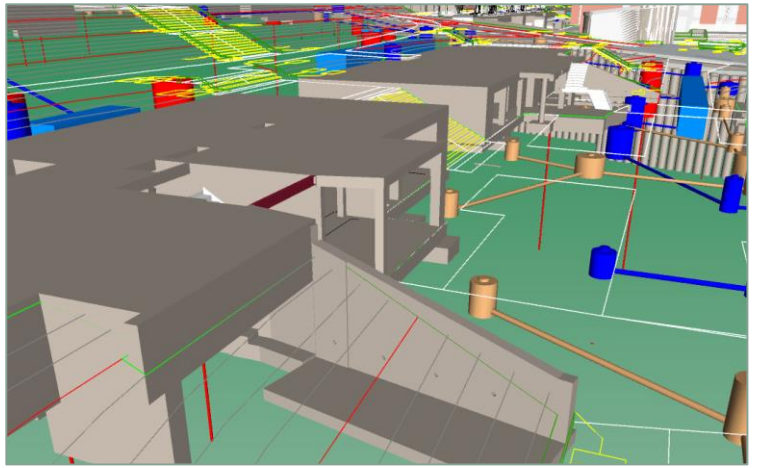
Case Study 1 – Retaining Wall Automation

ARUP

- Large site on a ~1:6 slope.



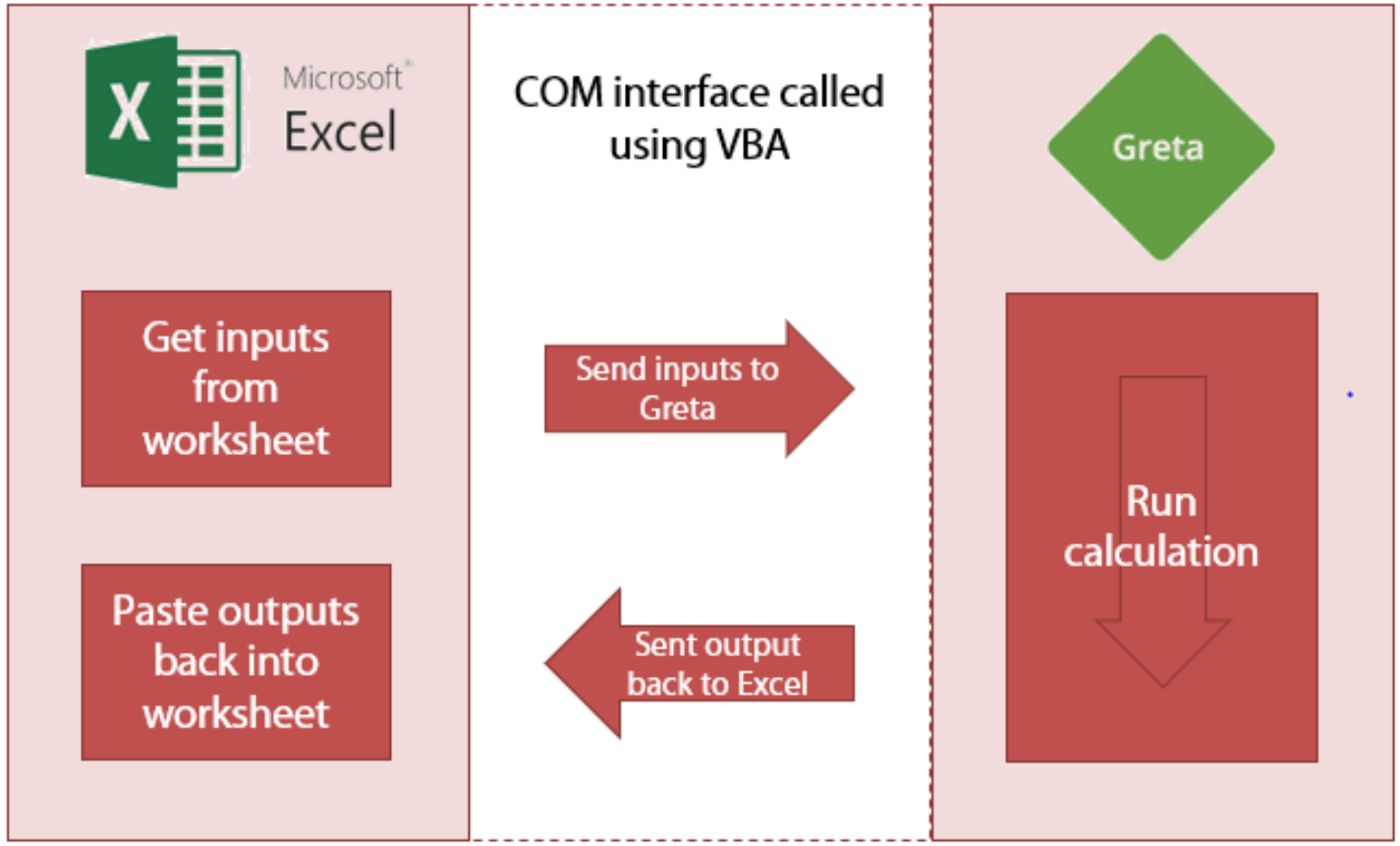
- Lots of terracing of the ground profile required
- Retained height, retained slope and geology varied



- Wanted an ‘off the shelf’ L section retaining wall solution to each situation, as the site layout was still being developed.

Case Study – Retaining Wall Automation

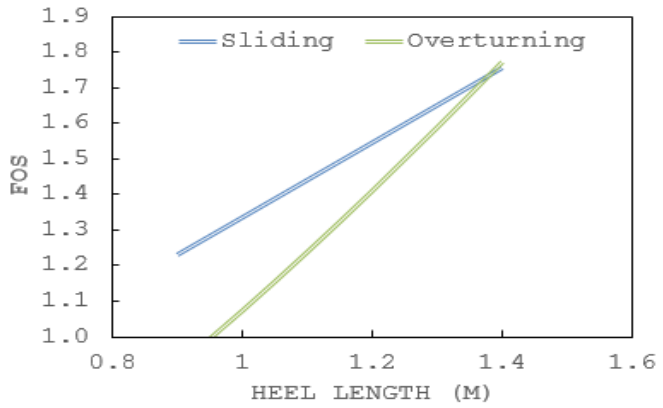
ARUP

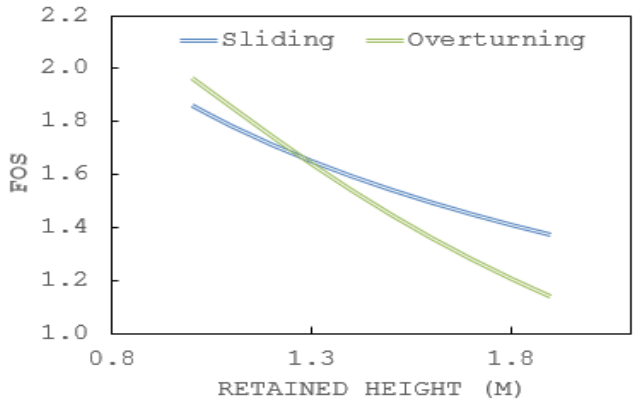


Why did we automate?

ARUP

- Design lots of walls very quickly, with just a table of input parameters.
  - Changing geometry
  - Changing soil parameters
- Easy to optimise designs
  - Iterate heel length to optimise FoS
  - Calculate max retained height for a given geometry
  - Sensitivity investigations – quickly plot outputs
- Incremental analyses
  - Get max bending moment from compaction pressures during incremental backfilling





Case Study 2 – Single Bored Pile Design

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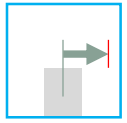
Inputs


Loads


Ground model

Base models

Pile properties


Displacement limit

Automated calculations

Calculation spreadsheet runs iterative design calculations:

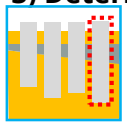
1) Lateral calculations

Four alp models per load case.
Length iterated to iteration limits.

2) Axial calculations

Axial (compression and tension) capacity calculations completed, for ULS1, ULS2 and SLS.
Pile length iterated until FoS = 1 in each case.

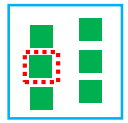
3) Determination of design length



… is the longest of any case (lateral or axial).

Outputs


Pile length


Critical case

Iterated models and log file


Extracted BM and displacement


Displacement interpretation

Opportunities from Automation

ARUP

- Time saving

  Overall time reduction dependant of size of analysis. The bigger the analysis the bigger the saving

  - Input data (40%)
  - Output generation / plotting maps (40%)
- Help us to avoid and prevent human errors
- Iterative / multiple analysis (RW movements, etc)
- Future plans for real-time monitoring.

  Back analysis and Observational Method

Challenges from Automation

ARUP

- Only small numbers of calculations or load cases required?

  Use on larger projects

- Less checking and reviewing could potentially and incorrectly be justified

  Check base model and outputs carefully. Models need to be created

- Difficult to check the code rather than calculations that have been presented step-by-step

  Developers within design teams?

Future Trends

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- Engineers or developers?
- Modular automation
- Interdisciplinary automation
- Design on demand

Discuss

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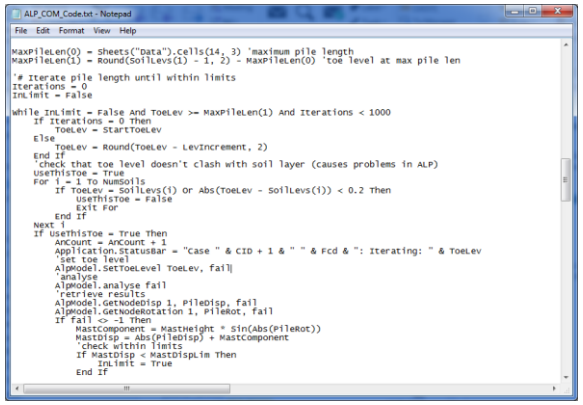

Automation in Geotechnics
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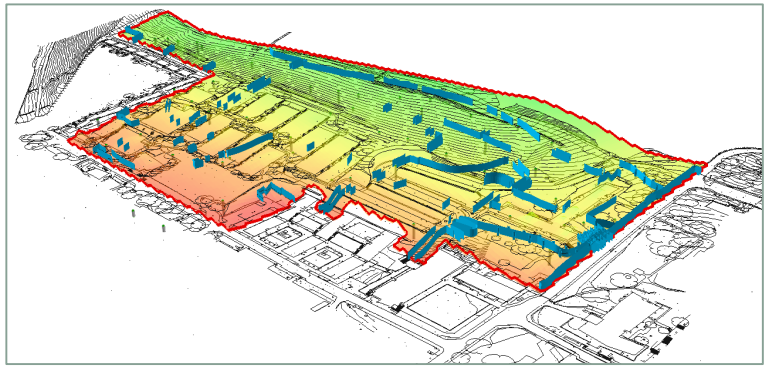

Visit us at Booth 15 (near the lifts)

Any Questions?