

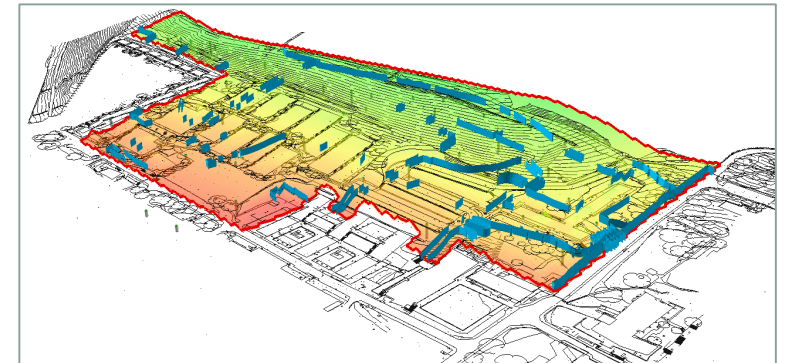
Geotechnical Analysis

```
ALP_COM_Code.txt - Notepad
File Edit Format View Help
MaxPileLen(0) = Sheets("Data").Cells(14, 3) 'maximum pile length
MaxPileLen(1) = Round(SoilLevs(1) - 1, 2) - MaxPileLen(0) 'toe level at max pile len
'Iterate pile length until within limits
Iterations = 0
InLimit = False
while InLimit = False And Toelev >= MaxPileLen(1) And Iterations < 1000
    If Iterations = 0 Then
        Toelev = StartToelev
    Else
        Toelev = Round(Toelev - LevIncrement, 2)
    End If
    'check that toe level doesn't clash with soil layer (causes problems in ALP)
    UseThisToe = True
    For i = 1 To NumSoils
        If Toelev = SoilLevs(i) Or Abs(Toelev - SoilLevs(i)) < 0.2 Then
            UseThisToe = False
            Exit For
        End If
    Next i
    If UseThisToe = True Then
        If Arcount = Arcount + 1
            Application.StatusBar = "Case " & CStr(Arcount + 1) & " & Pcd & ": Iterating: " & Toelev
            Set Toelev
            Almodel.SetToeLevel Toelev, fail
            analyse
            Almodel.analyse fail
            'retrieve results
            Almodel.getnodedisp i, Piledisp, fail
            Almodel.getnodedisp 1, PileRot, fail
            If fail <> -1 Then
                MastComponent = MastHeight * Sin(Abs(PileRot))
                MastDisp = Abs(Piledisp) + MastComponent
                'check within limits
                If MastDisp < MastDisplim Then
                    InLimit = True
                    Exit For
                End If
            End If
        End If
    End If
    Iterations = Iterations + 1
end while
```

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

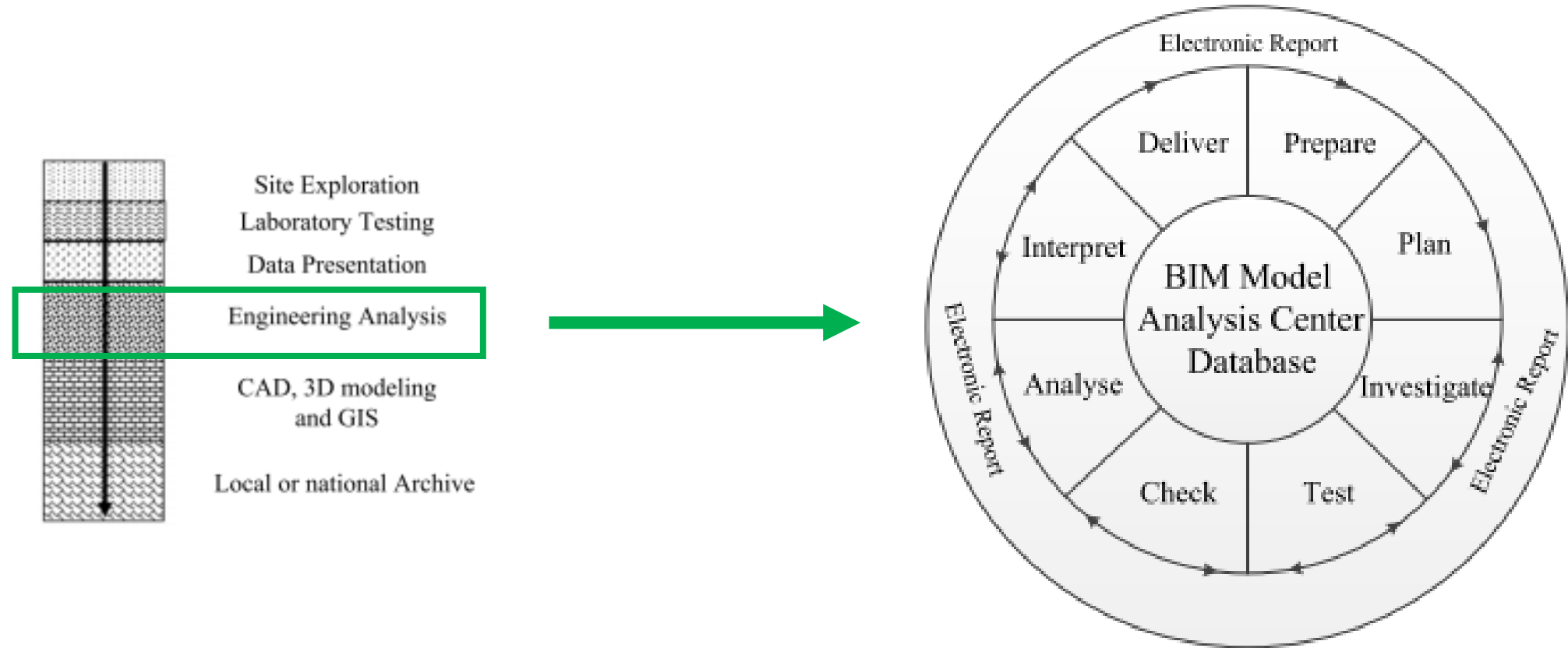


Universities using Oasys



Why Automate?

ARUP



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

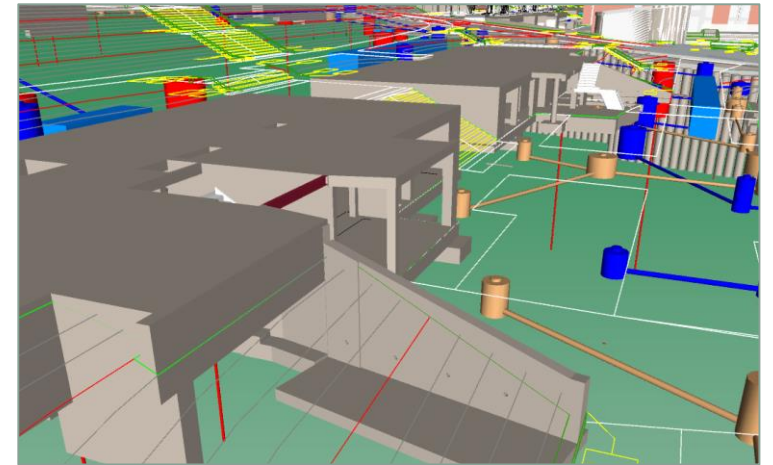
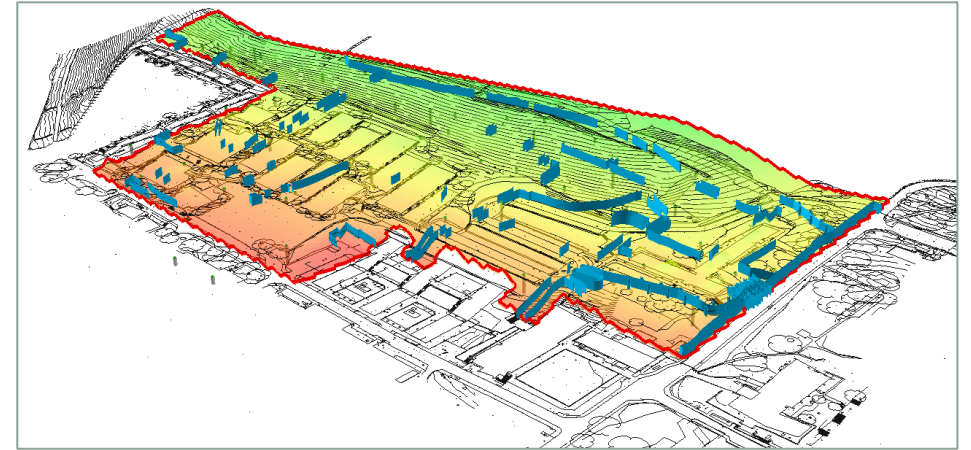
Where can we Automate?

- 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

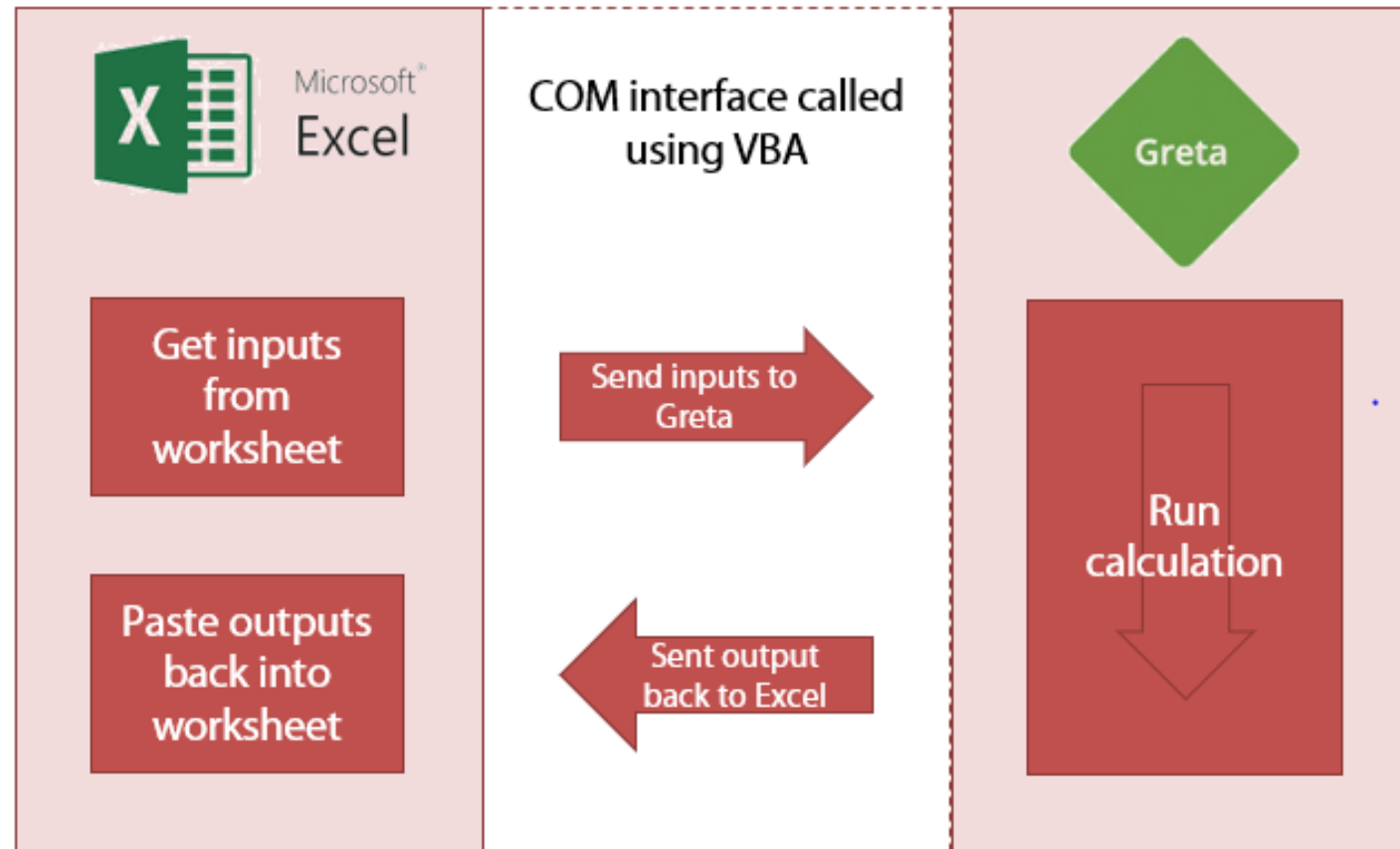
ARUP

- 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

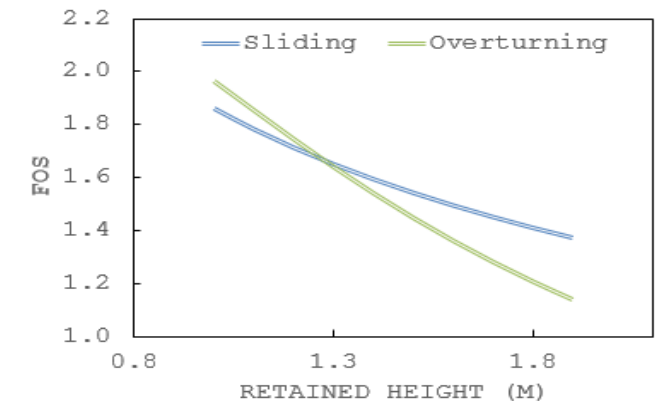
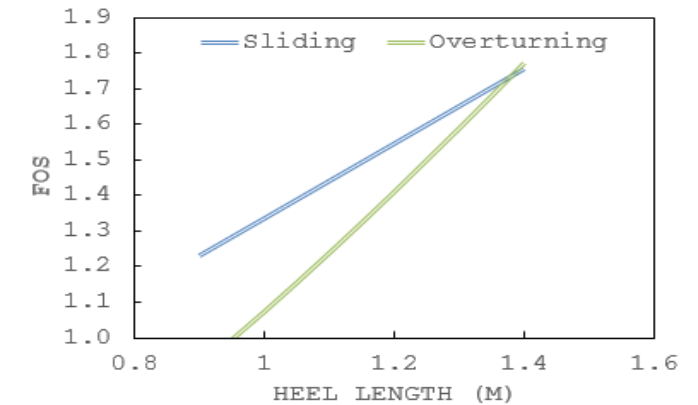
ARUP



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

Inputs



Loads



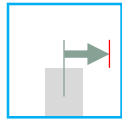
Ground model



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.



ULS 1



ULS 2

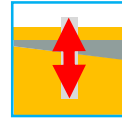


SLS 1



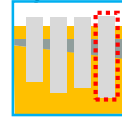
SLS 2

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

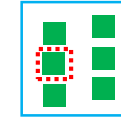


... is the longest of any case (lateral or axial).

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

ARUP

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



Discuss

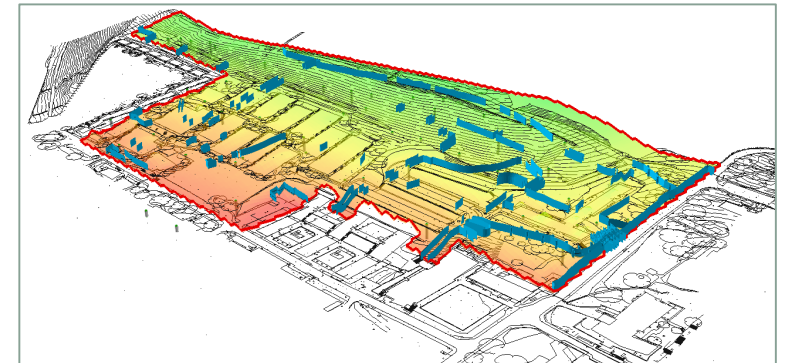
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Automation in Geotechnics Case Studies and Future Innovation

Visit us at Booth 15 (near the lifts)



Any Questions?

