UNIVERSITY OF TECHNOLOGY SYDNEY

MATLAB ACADEMIC CONFERENCE 2016

Using MATLAB as a Modelling Tool for Civil Engineering Design Projects

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4 July 2016

OUTLINE

- What is a Capstone Project?
- Ideas for Capstone Projects
- MATLAB: An Effective Tool for Training
- An Example: Compare Main Design Methods for Various Retaining Walls
- A Selection of Other Projects at a Glance
- Concluding Remarks

What is a Capstone Project?

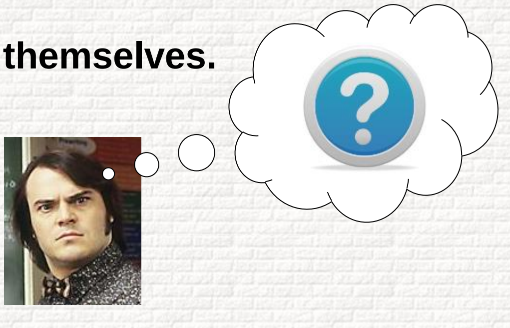
What is a Capstone Project?

- Final year undergraduate students at the University of Technology Sydney undertake a year-long individual design or research subject, called capstone project. (12 credit points)
- Students apply the skills and knowledge, acquired in their coursework to a practical project.
- It is an opportunity for students to demonstrate that they can meet the levels of performance expected of a professional engineer.

Ideas for Capstone Projects

Ideas for Capstone Projects

- Ideas for the capstone projects can be suggested by:
  - the academic supervisors,
  - industry, or
  - the students themselves.



Approaches for Capstone Projects

Experimental Investigation

Numerical Analysis

Filed Measurements

Analytical/Mathematical

Developing Programs for Design Projects

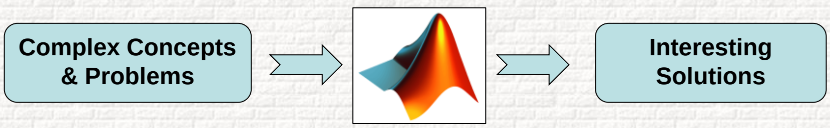
MATLAB:

An Effective Tool for Training

MATLAB: An Effective Tool for Training

It has been realised that MATLAB can be used as a highly effective tool for training final year capstone students in Civil Engineering Discipline.

It makes the study of complex concepts more interesting.



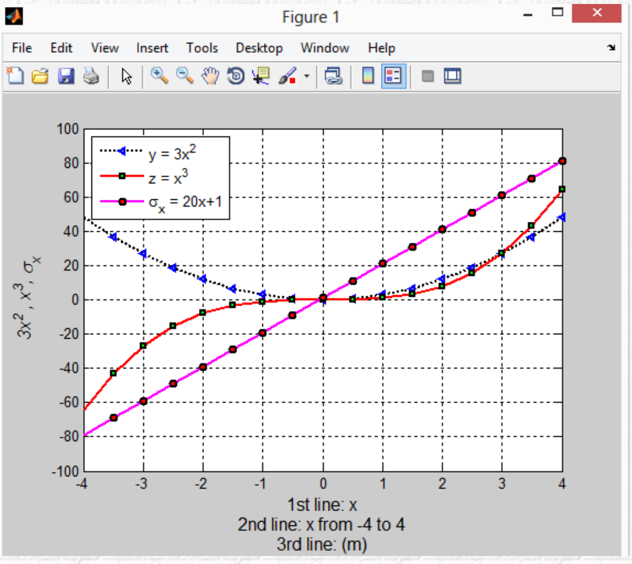
MATLAB: An Effective Tool for Training

Each semester, I organise a number of intensive training sessions for my capstone students to be familiar with ***the main features*** of MATLAB.

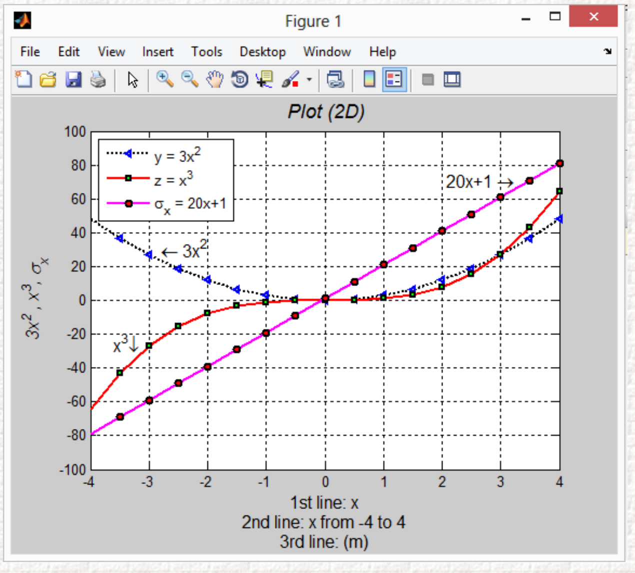
They are: programming approaches and techniques, graphics, optimisation toolbox, statistics toolbox, symbolic toolbox and graphical user interface.

Accordingly, capstone students can quickly generate results and then plot or animate their results via an interactive interface, without being inundated in low-level programing details.

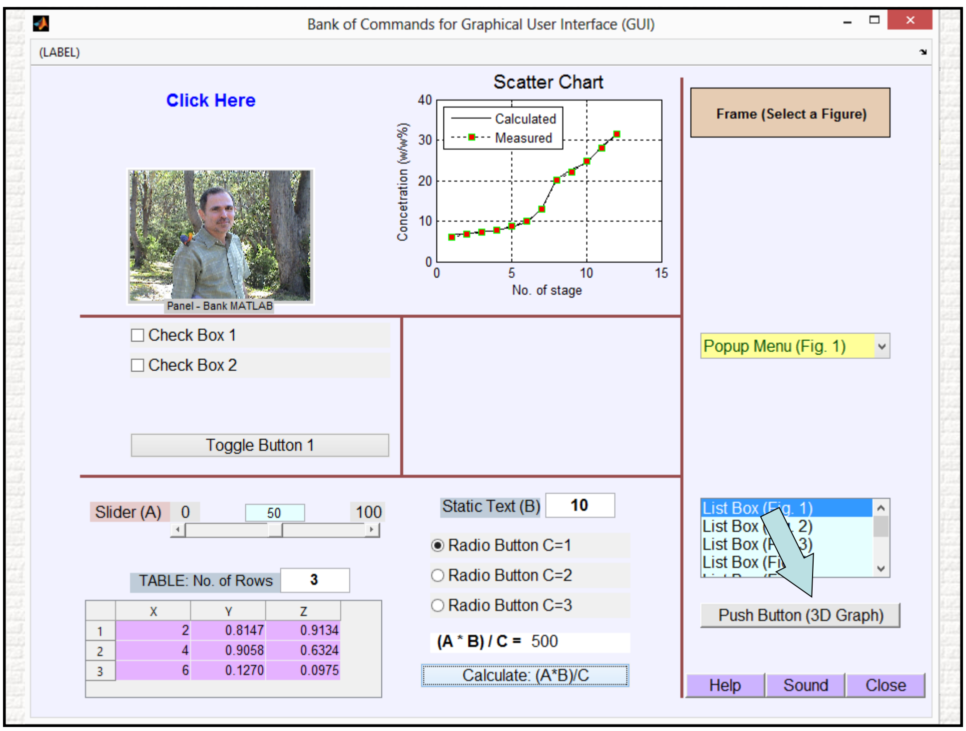
MATLAB: An Effective Tool for Training



MATLAB: An Effective Tool for Training




Bank of Commands for Graphical User Interface (GUI)
(LABEL)
Click Here
Panel - Bank MATLAB
Scatter Chart
Calculated
Measured
Concetration (w/w%)
No. of stage
Frame (Select a Figure)
Check Box 1
Check Box 2
Toggle Button 1
Popup Menu (Fig. 1)
Slider (A)
0
50
100
Static Text (B)
10
Radio Button C=1
Radio Button C=2
Radio Button C=3
TABLE: No. of Rows
3
X Y Z
1 2 0.8147 0.9134
2 4 0.9058 0.6324
3 6 0.1270 0.0975
Calculate: (A*B)/C
List Box (Fig. 1)
List Box (Fig. 2)
List Box (Fig. 3)
List Box (Fig. 4)
Push Button (3D Graph)
Help
Sound
Close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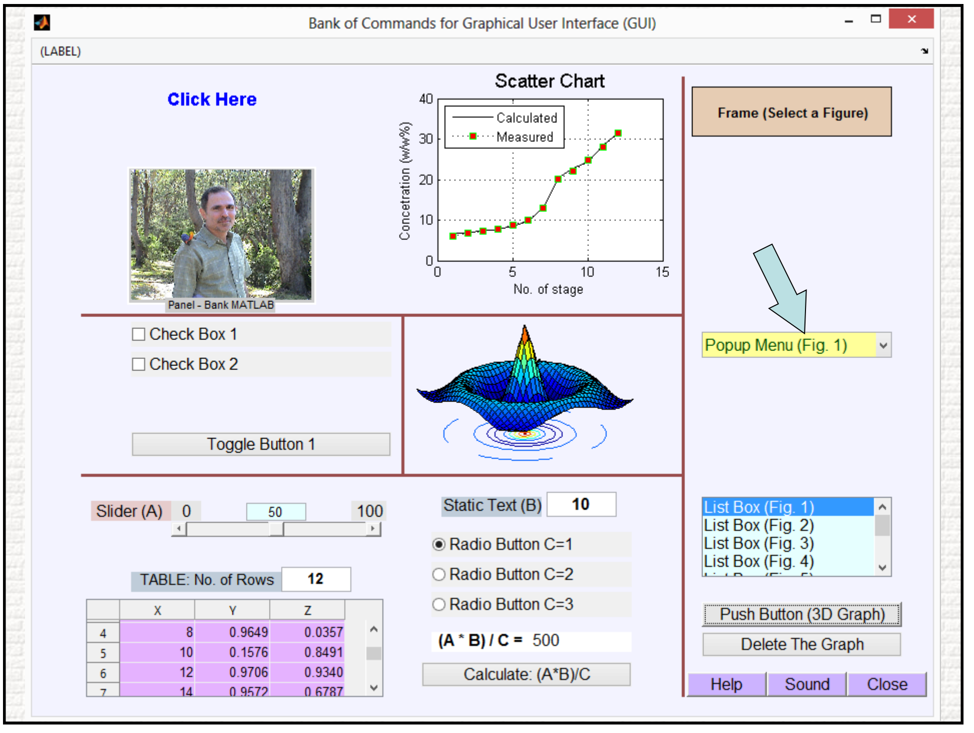
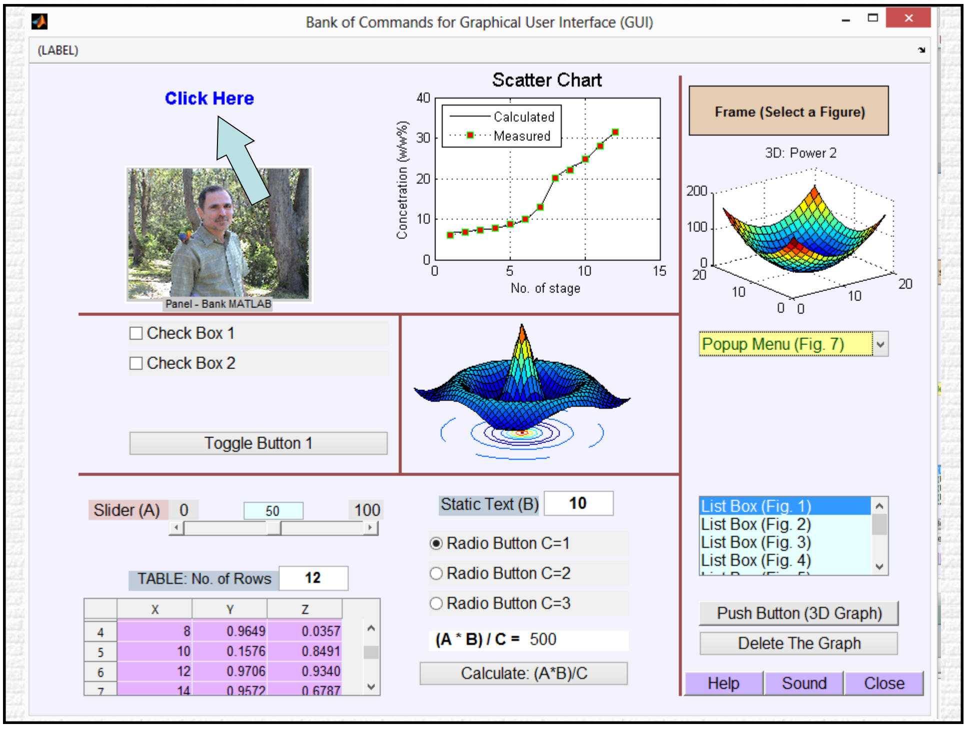
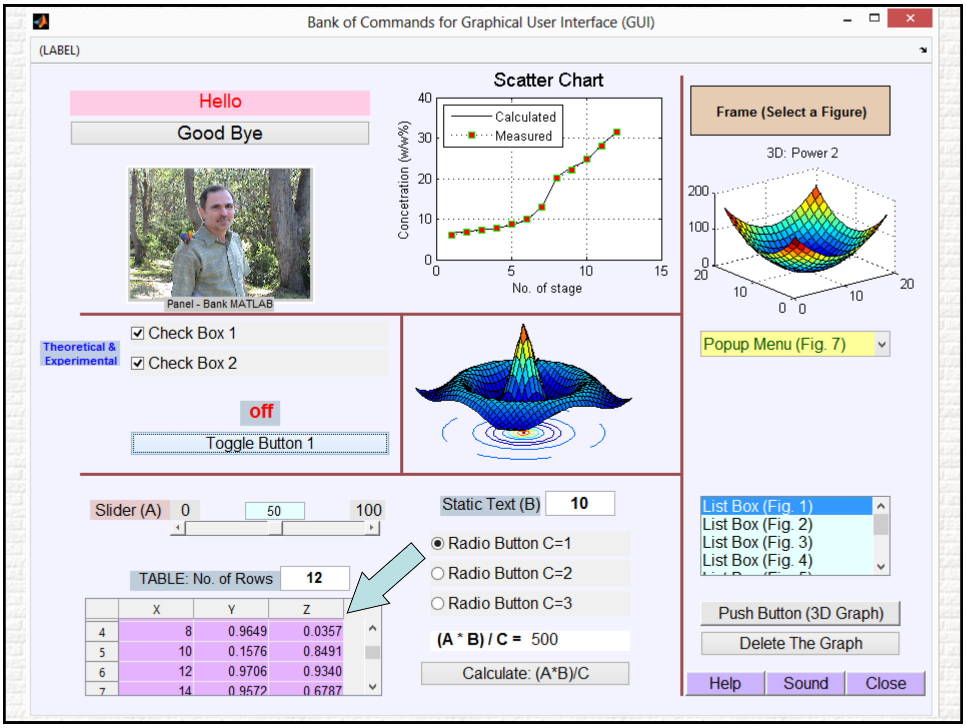
Toggle Button 1
Popup Menu (Fig. 1)
Slider (A)
0
50
100
Static Text (B)
10
Radio Button C=1
Radio Button C=2
Radio Button C=3
TABLE: No. of Rows
3
X Y Z
1 2 0.8147 0.9134
2 4 0.9058 0.6324
3 6 0.1270 0.0975
(A * B) / C = 500
Calculate: (A*B)/C
List Box (Fig. 1)
Push Button (3D Graph)
Help
Sound
Close


Bank of Commands for Graphical User Interface (GUI)
(LABEL)
Click Here
Panel - Bank MATLAB
Scatter Chart
Calculated
Measured
Concetration (w/w%)
No. of stage
Frame (Select a Figure)
Popup Menu (Fig. 1)
Check Box 1
Check Box 2
Toggle Button 1
Slider (A)
Static Text (B)
Radio Button C=1
Radio Button C=2
Radio Button C=3
TABLE: No. of Rows
(A * B) / C = 500
Calculate: (A*B)/C
List Box (Fig. 1)
List Box (Fig. 2)
List Box (Fig. 3)
List Box (Fig. 4)
Push Button (3D Graph)
Delete The Graph
Help
Sound
Close


Bank of Commands for Graphical User Interface (GUI)
(LABEL)
Click Here
Panel - Bank MATLAB
Scatter Chart
Calculated
Measured
Concetration (w/w%)
No. of stage
Frame (Select a Figure)
3D: Power 2
Popup Menu (Fig. 7)
Check Box 1
Check Box 2
Toggle Button 1
Slider (A)
Static Text (B)
Radio Button C=1
Radio Button C=2
Radio Button C=3
TABLE: No. of Rows
(A * B) / C = 500
Calculate: (A*B)/C
List Box (Fig. 1)
List Box (Fig. 2)
List Box (Fig. 3)
List Box (Fig. 4)
Push Button (3D Graph)
Delete The Graph
Help
Sound
Close



1. How do you get the revised data of the table when you edit them?

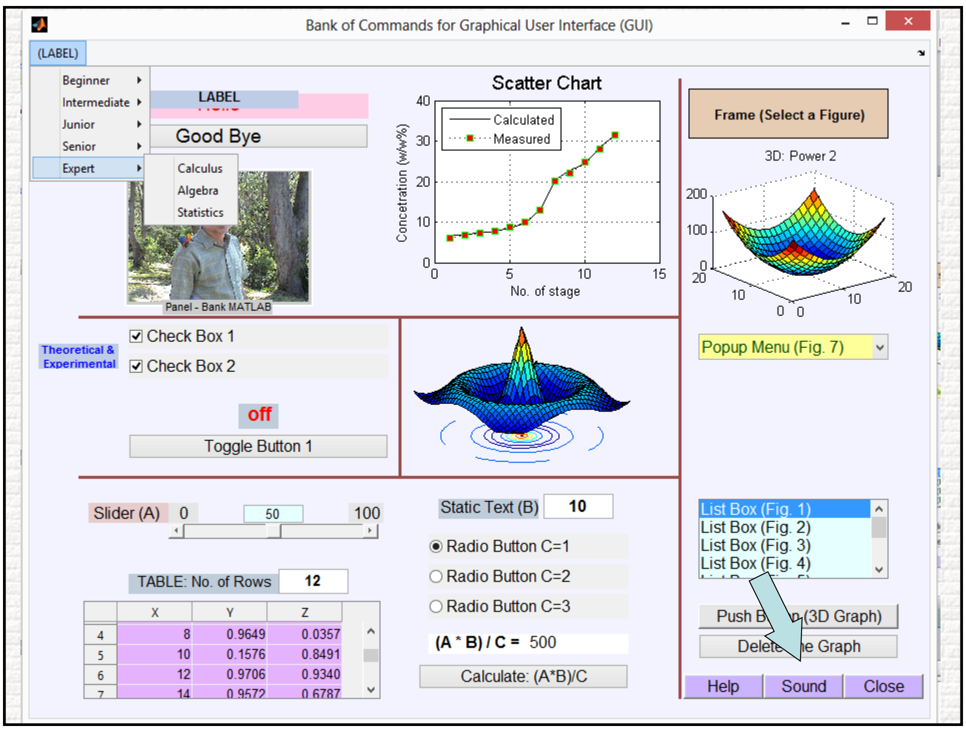
2. Assume the table is a large matrix; how do you get only the data of the last column?

Answer

TD = get (table1,'data')   % table data

D = size (TD)   % row and column size

LCD = TD(:, D(2))   % last col. data



	X	Y	Z
4	8	0.9649	0.0357
5	10	0.1576	0.8491
6	12	0.9706	0.9340
7	14	0.9572	0.6787

QUIZ

How do you add a sound file to your program?

Answer

File name

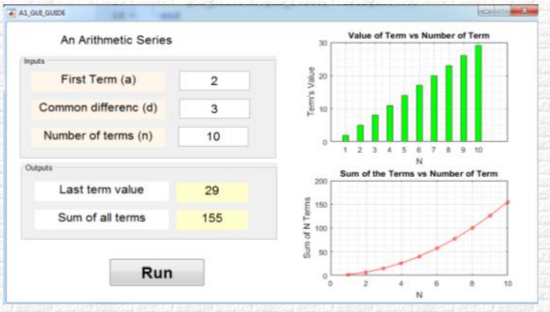
```
[y,Fs] = audioread ('bankm_sound.wav')
% Play the audio
sound (y, Fs);
```

Graphical User Interface (GUI)

1. Method One: Figure/Text Based GUI
2. Method Two: Figure/Set Based GUI
3. Method Three: Figure/Function Based GUI
4. Method Four: Guide Based GUI

See the handout for all methods .

Through a simple example, you can learn how to write GUI codes **as easy as drinking a glass of water.**

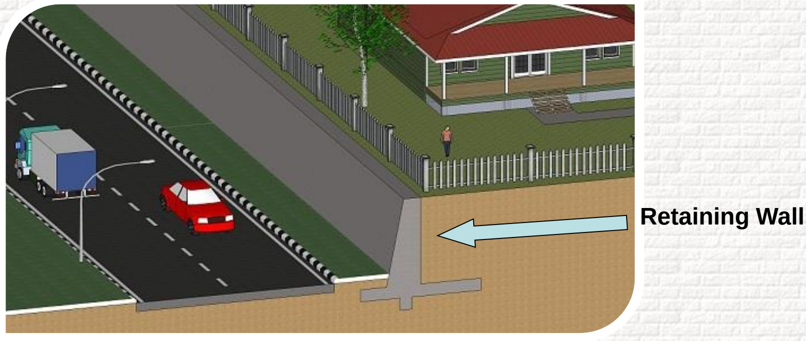


An Example:

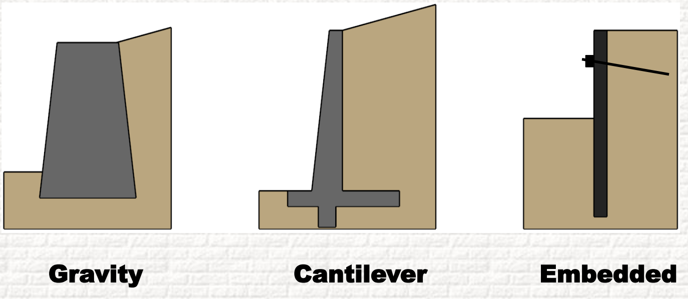
Comparing Main Design Methods for Various Retaining Walls

Main Design Methods of Retaining Walls

Comparison of the Global Factor of Safety to the Partial Factors of Safety Used by the Australian Standard, AS 4678-2002, for Earth Retaining Structures

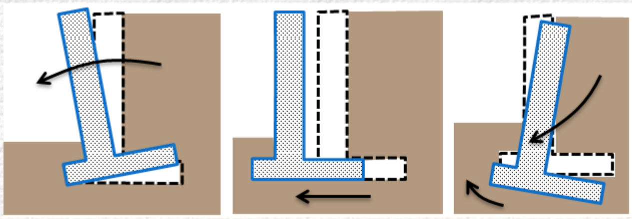


Various Types Retaining Walls

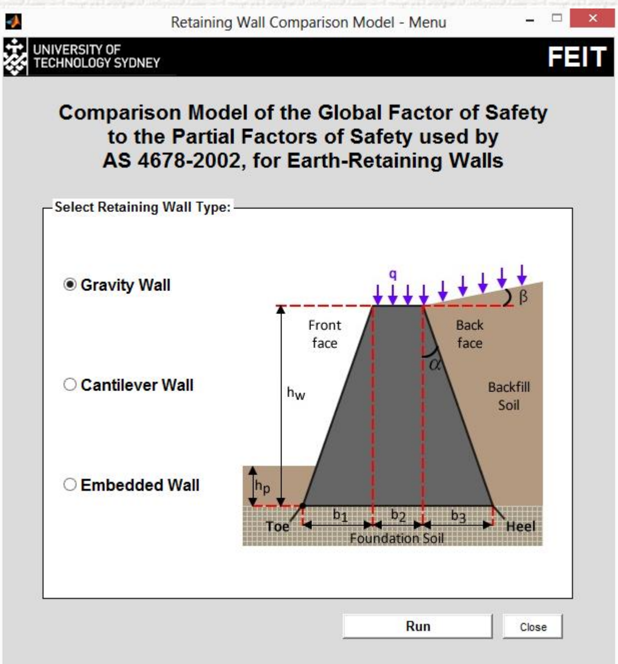


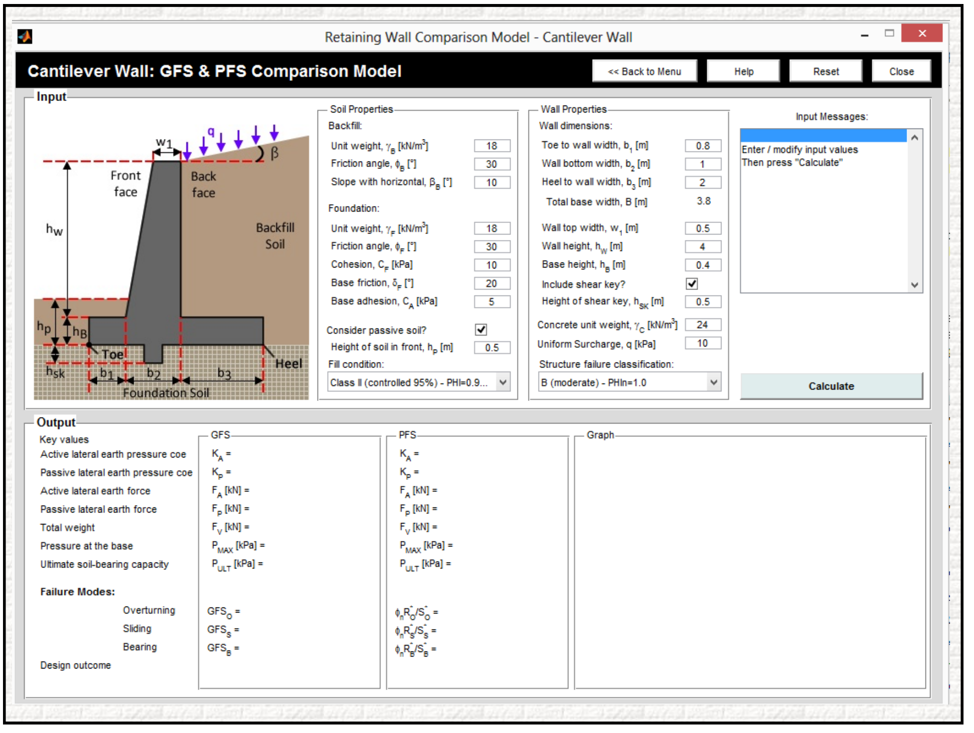
Failure Modes in Retaining Walls

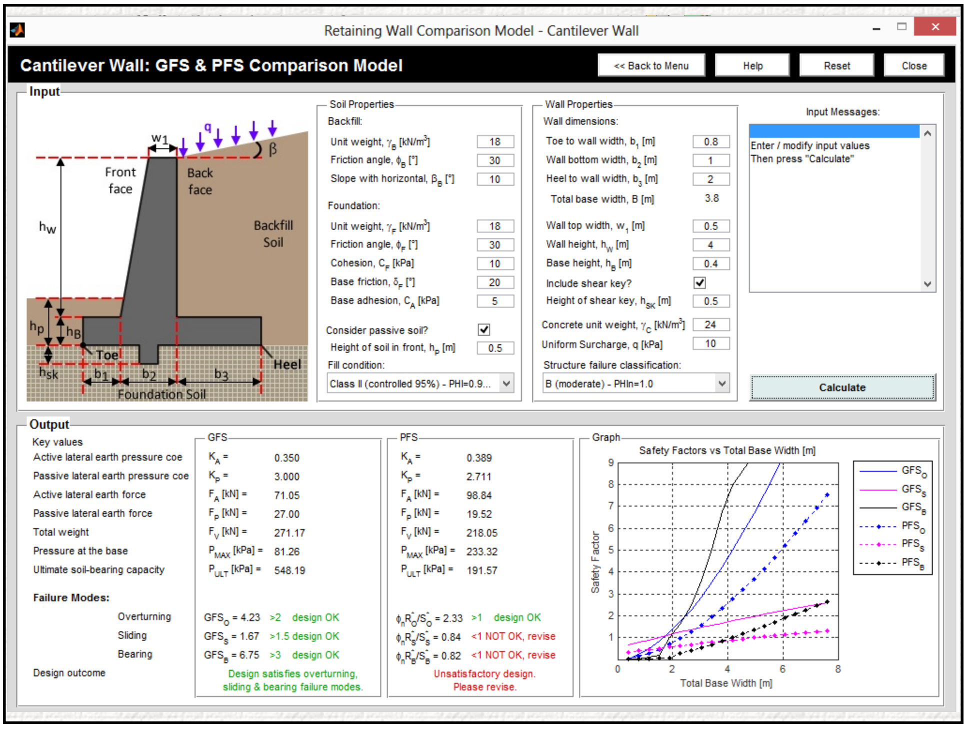
- **Analysis carried out for main 3 failure modes:**

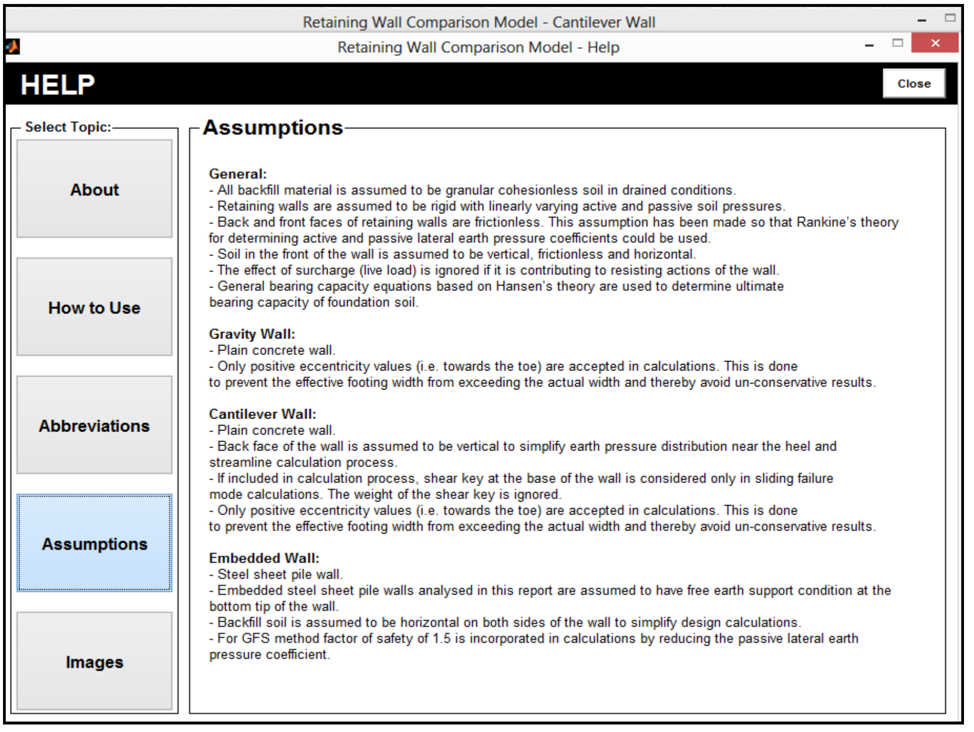


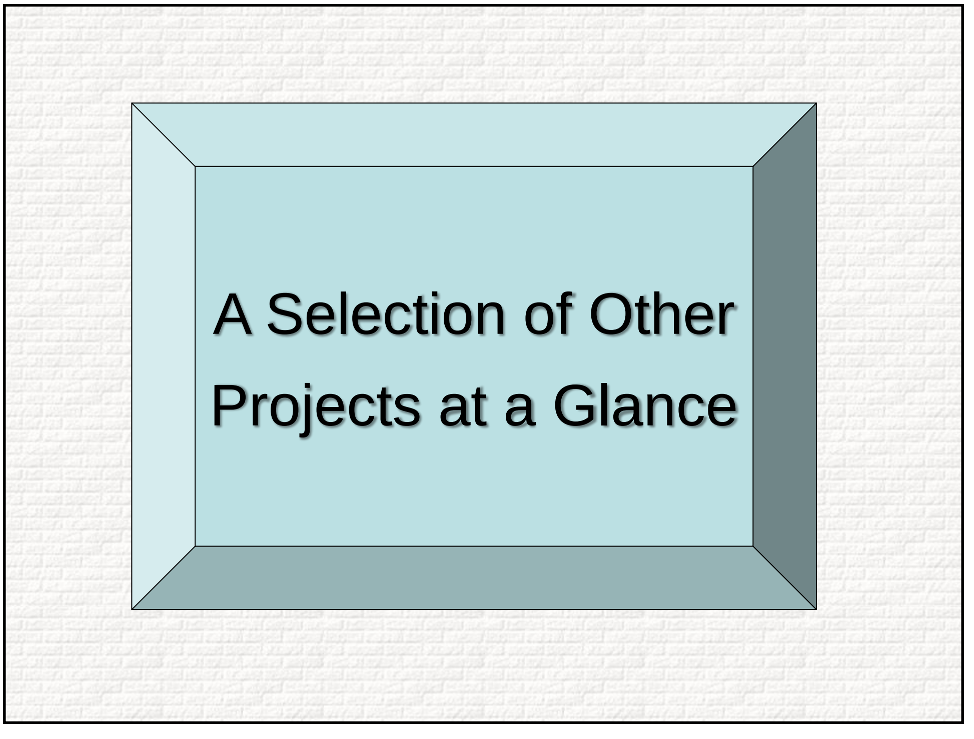
Overturning Failure **Sliding Failure** **Bearing Failure**




Retaining Wall Comparison Model - Cantilever Wall
Cantilever Wall: GFS & PFS Comparison Model
<< Back to Menu
Help
Reset
Close
Input
Soil Properties
Wall Properties
Input Messages:
Enter / modify input values
Then press "Calculate"
Calculate
Output
Key values
GFS
PFS
Graph
Failure Modes:
Design outcome


Retaining Wall Comparison Model - Cantilever Wall
Cantilever Wall: GFS & PFS Comparison Model
Input
Soil Properties
Wall Properties
Calculate
Output
Graph
Safety Factors vs Total Base Width [m]
Safety Factor
Total Base Width [m]
Design satisfies overturning, sliding & bearing failure modes.
Unsatisfactory design. Please revise.


Retaining Wall Comparison Model - Cantilever Wall
Retaining Wall Comparison Model - Help
HELP
Close
Select Topic:
About
How to Use
Abbreviations
Assumptions
Images
Assumptions
General:
- All backfill material is assumed to be granular cohesionless soil in drained conditions.
- Retaining walls are assumed to be rigid with linearly varying active and passive soil pressures.
- Back and front faces of retaining walls are frictionless. This assumption has been made so that Rankine's theory for determining active and passive lateral earth pressure coefficients could be used.
- Soil in the front of the wall is assumed to be vertical, frictionless and horizontal.
- The effect of surcharge (live load) is ignored if it is contributing to resisting actions of the wall.
- General bearing capacity equations based on Hansen's theory are used to determine ultimate bearing capacity of foundation soil.
Gravity Wall:
- Plain concrete wall.
- Only positive eccentricity values (i.e. towards the toe) are accepted in calculations. This is done to prevent the effective footing width from exceeding the actual width and thereby avoid un-conservative results.
Cantilever Wall:
- Plain concrete wall.
- Back face of the wall is assumed to be vertical to simplify earth pressure distribution near the heel and streamline calculation process.
- If included in calculation process, shear key at the base of the wall is considered only in sliding failure mode calculations. The weight of the shear key is ignored.
- Only positive eccentricity values (i.e. towards the toe) are accepted in calculations. This is done to prevent the effective footing width from exceeding the actual width and thereby avoid un-conservative results.
Embedded Wall:
- Steel sheet pile wall.
- Embedded steel sheet pile walls analysed in this report are assumed to have free earth support condition at the bottom tip of the wall.
- Backfill soil is assumed to be horizontal on both sides of the wall to simplify design calculations.
- For GFS method factor of safety of 1.5 is incorporated in calculations by reducing the passive lateral earth pressure coefficient.


A Selection of Other Projects at a Glance

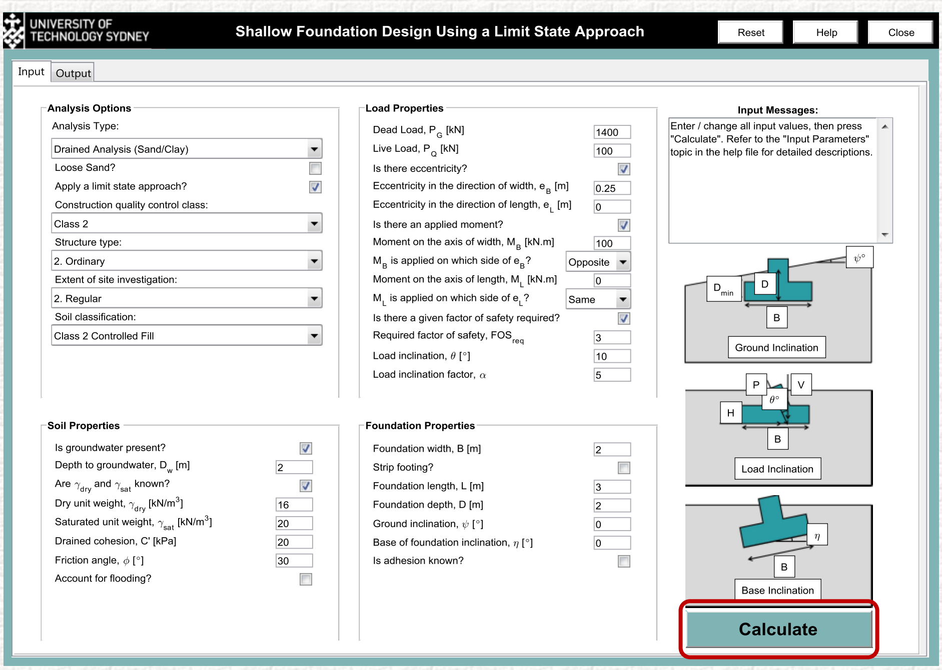
More Examples for Geotechnical Engineering

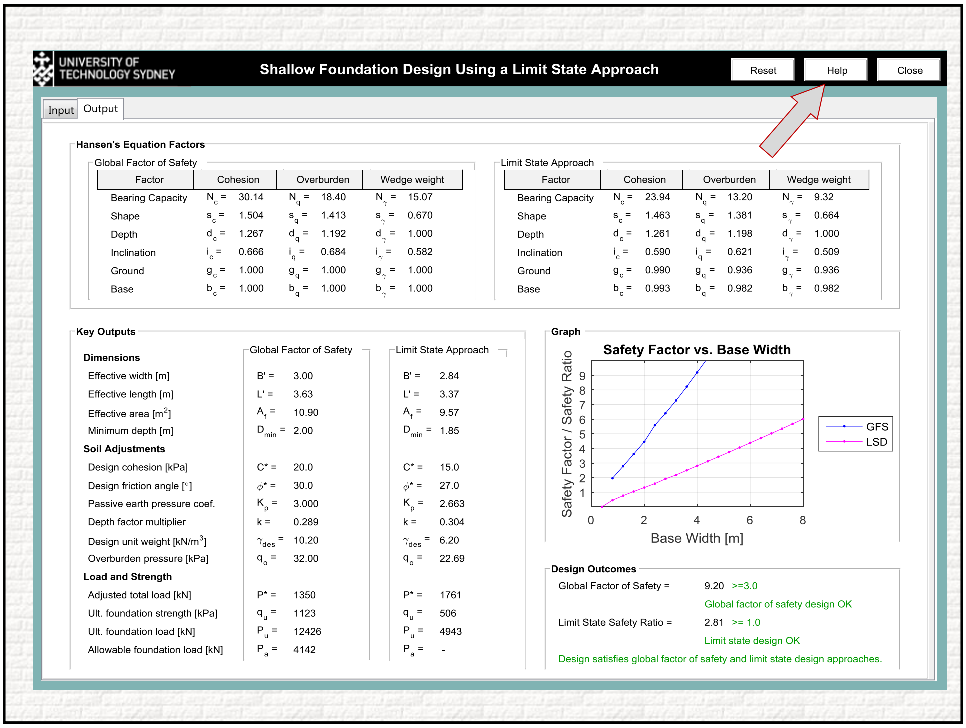
Shallow Foundation Design

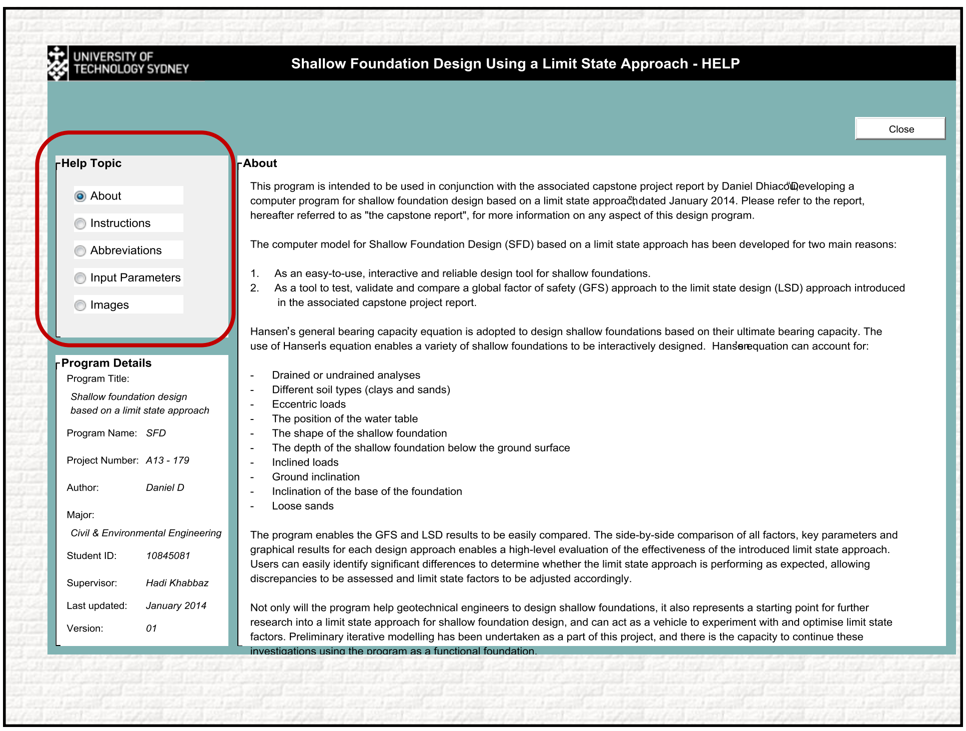
1. Global Factor of Safety
2. Limit State Design (Partial Factors of Safety)

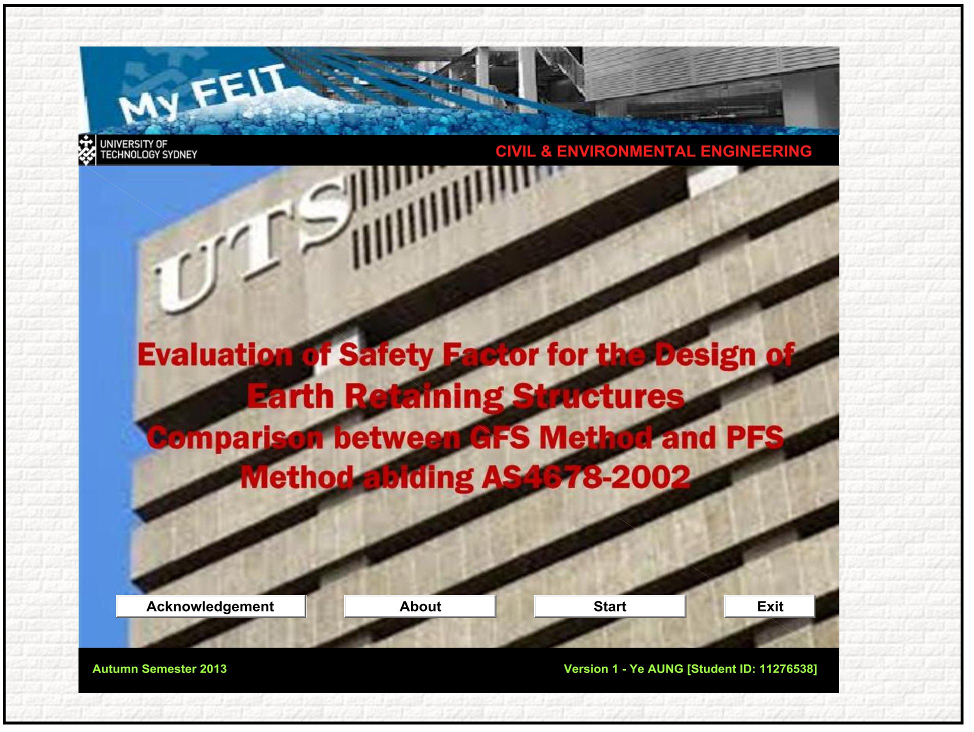
Anchored Wall Design in Layers Soil

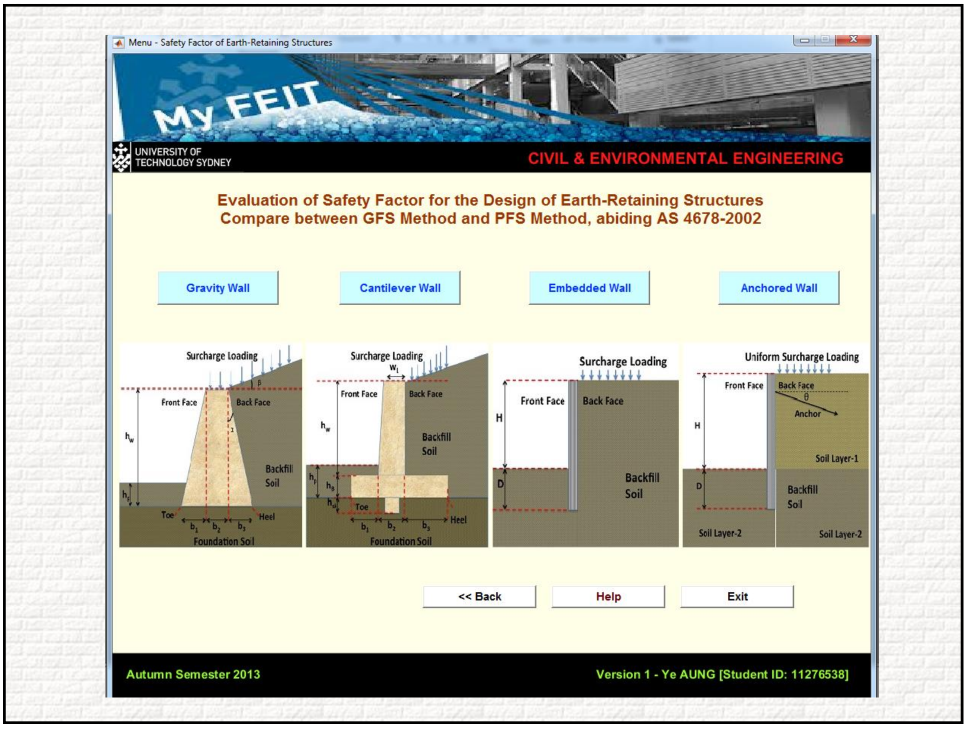
1. Global Factor of Safety
2. Limit State Design (Partial Factors of Safety)

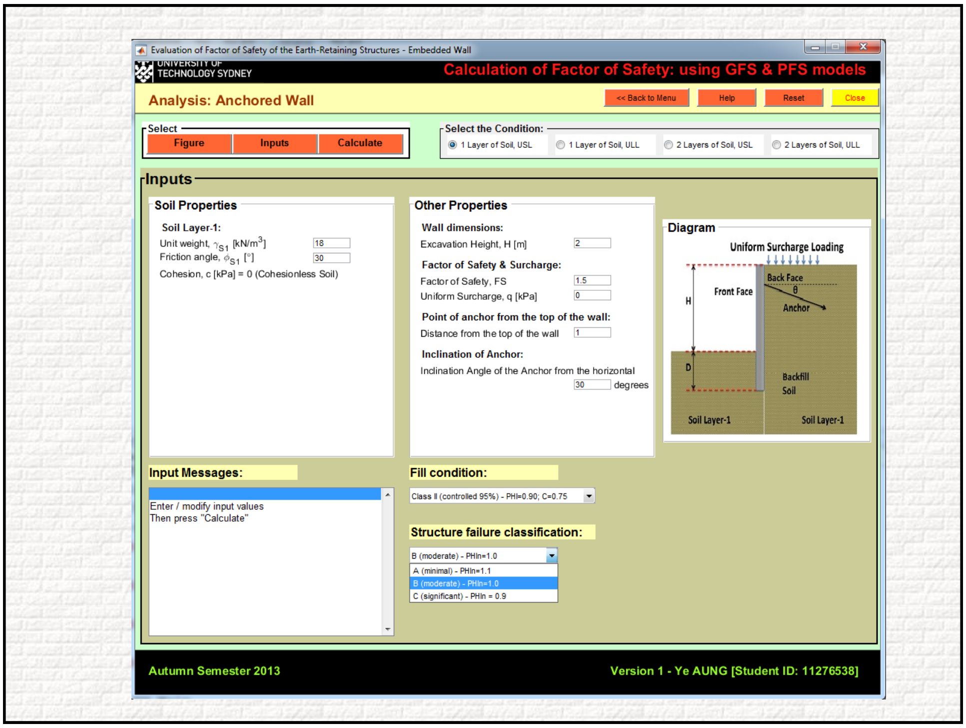


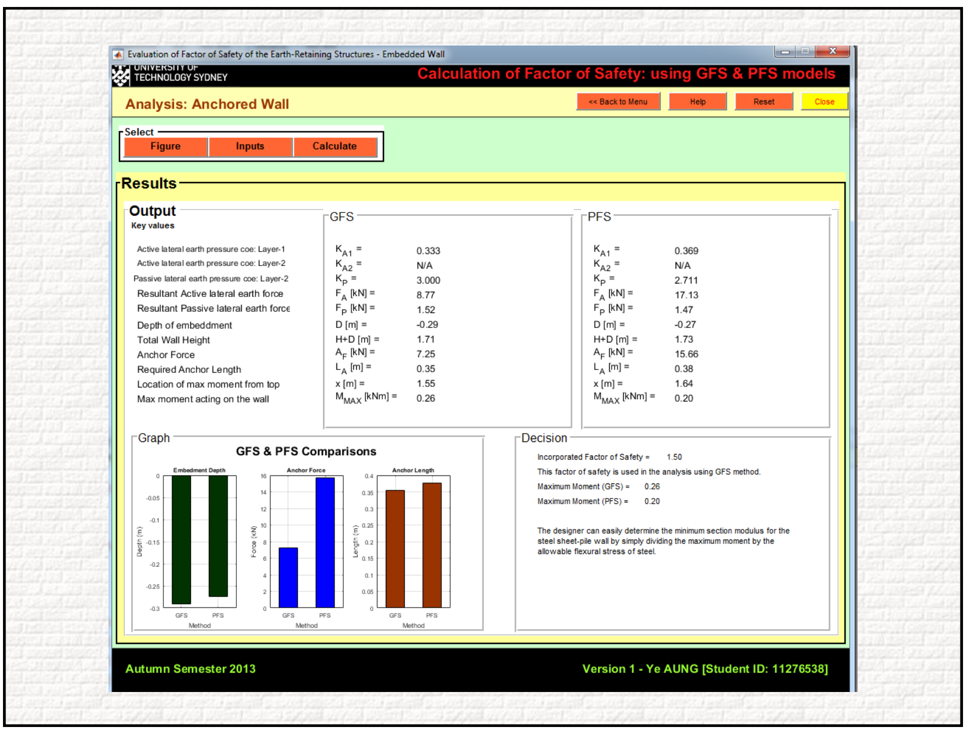

UNIVERSITY OF TECHNOLOGY SYDNEY
Shallow Foundation Design Using a Limit State Approach
Reset
Help
Close
Input
Output
Hansen's Equation Factors
Global Factor of Safety
Factor | Cohesion | Overburden | Wedge weight
Bearing Capacity Nc = 30.14 Nq = 18.40 Nγ = 15.07
Shape sc = 1.504 sq = 1.413 sγ = 0.670
Depth dc = 1.267 dq = 1.192 dγ = 1.000
Inclination ic = 0.666 iq = 0.684 iγ = 0.582
Ground gc = 1.000 gq = 1.000 gγ = 1.000
Base bc = 1.000 bq = 1.000 bγ = 1.000
Limit State Approach
Factor | Cohesion | Overburden | Wedge weight
Bearing Capacity Nc = 23.94 Nq = 13.20 Nγ = 9.32
Shape sc = 1.463 sq = 1.381 sγ = 0.664
Depth dc = 1.261 dq = 1.198 dγ = 1.000
Inclination ic = 0.590 iq = 0.621 iγ = 0.509
Ground gc = 0.990 gq = 0.936 gγ = 0.936
Base bc = 0.993 bq = 0.982 bγ = 0.982
Key Outputs
Global Factor of Safety
Limit State Approach
Dimensions
Effective width [m] B' = 3.00 B' = 2.84
Effective length [m] L' = 3.63 L' = 3.37
Effective area [m2] Af = 10.90 Af = 9.57
Minimum depth [m] Dmin = 2.00 Dmin = 1.85
Soil Adjustments
Design cohesion [kPa] C* = 20.0 C* = 15.0
Design friction angle [°] ϕ* = 30.0 ϕ* = 27.0
Passive earth pressure coef. Kp = 3.000 Kp = 2.663
Depth factor multiplier k = 0.289 k = 0.304
Design unit weight [kN/m3] γdes = 10.20 γdes = 6.20
Overburden pressure [kPa] qo = 32.00 qo = 22.69
Load and Strength
Adjusted total load [kN] P* = 1350 P* = 1761
Ult. foundation strength [kPa] qu = 1123 qu = 506
Ult. foundation load [kN] Pu = 12426 Pu = 4943
Allowable foundation load [kN] Pa = 4142 Pa = -
Graph
Safety Factor vs. Base Width
Safety Factor / Safety Ratio
Base Width [m]
0 2 4 6 8
1 2 3 4 5 6 7 8 9
GFS
LSD
Design Outcomes
Global Factor of Safety = 9.20 >=3.0
Global factor of safety design OK
Limit State Safety Ratio = 2.81 >= 1.0
Limit state design OK
Design satisfies global factor of safety and limit state design approaches.


UNIVERSITY OF TECHNOLOGY SYDNEY
Shallow Foundation Design Using a Limit State Approach - HELP
Close
Help Topic
About
Instructions
Abbreviations
Input Parameters
Images
Program Details
Program Title:
Shallow foundation design based on a limit state approach
Program Name: SFD
Project Number: A13 - 179
Author: Daniel D
Major:
Civil & Environmental Engineering
Student ID: 10845081
Supervisor: Hadi Khabbaz
Last updated: January 2014
Version: 01
About
This program is intended to be used in conjunction with the associated capstone project report by Daniel Dhiacou, Developing a computer program for shallow foundation design based on a limit state approach, dated January 2014. Please refer to the report, hereafter referred to as "the capstone report", for more information on any aspect of this design program.
The computer model for Shallow Foundation Design (SFD) based on a limit state approach has been developed for two main reasons:
1. As an easy-to-use, interactive and reliable design tool for shallow foundations.
2. As a tool to test, validate and compare a global factor of safety (GFS) approach to the limit state design (LSD) approach introduced in the associated capstone project report.
Hansen's general bearing capacity equation is adopted to design shallow foundations based on their ultimate bearing capacity. The use of Hansen's equation enables a variety of shallow foundations to be interactively designed. Hansen's equation can account for:
- Drained or undrained analyses
- Different soil types (clays and sands)
- Eccentric loads
- The position of the water table
- The shape of the shallow foundation
- The depth of the shallow foundation below the ground surface
- Inclined loads
- Ground inclination
- Inclination of the base of the foundation
- Loose sands
The program enables the GFS and LSD results to be easily compared. The side-by-side comparison of all factors, key parameters and graphical results for each design approach enables a high-level evaluation of the effectiveness of the introduced limit state approach. Users can easily identify significant differences to determine whether the limit state approach is performing as expected, allowing discrepancies to be assessed and limit state factors to be adjusted accordingly.
Not only will the program help geotechnical engineers to design shallow foundations, it also represents a starting point for further research into a limit state approach for shallow foundation design, and can act as a vehicle to experiment with and optimise limit state factors. Preliminary iterative modelling has been undertaken as a part of this project, and there is the capacity to continue these investigations using the program as a functional foundation.

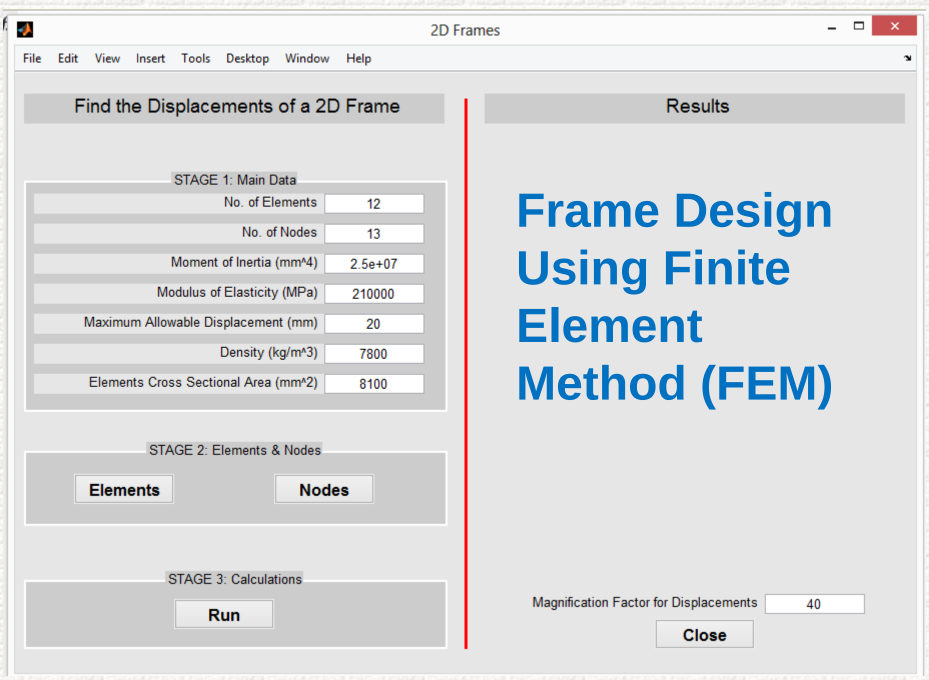

My FEIT
UNIVERSITY OF TECHNOLOGY SYDNEY
CIVIL & ENVIRONMENTAL ENGINEERING
UTS
Evaluation of Safety Factor for the Design of Earth Retaining Structures
Comparison between GFS Method and PFS Method abiding AS4678-2002
Acknowledgement
About
Start
Exit
Autumn Semester 2013
Version 1 - Ye AUNG [Student ID: 11276538]

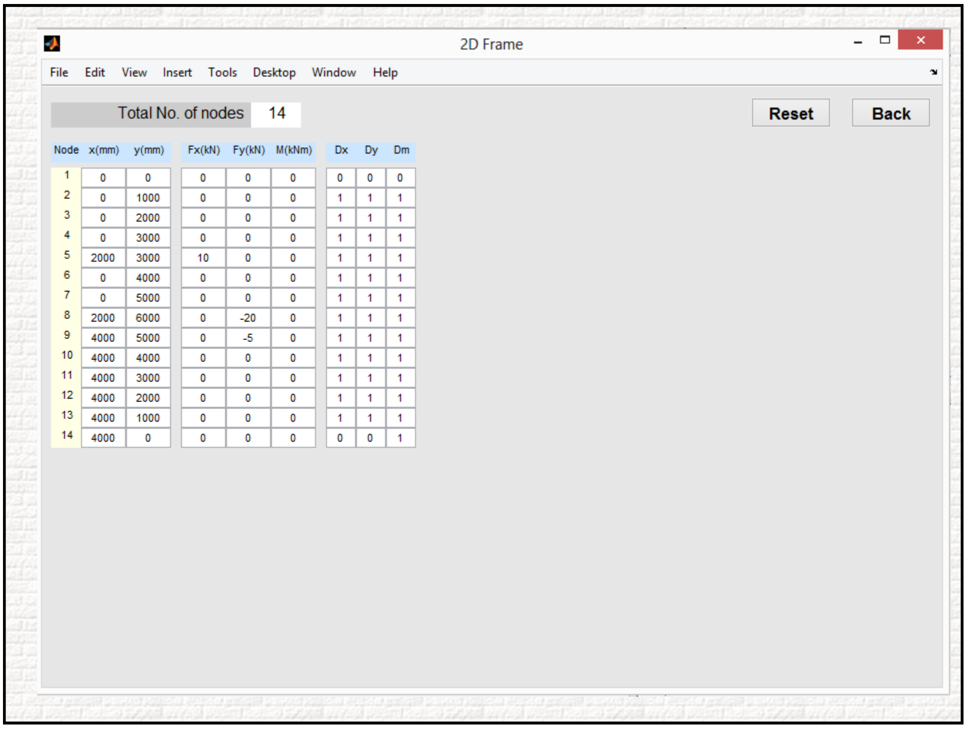

Menu - Safety Factor of Earth-Retaining Structures
My FEIT
UNIVERSITY OF TECHNOLOGY SYDNEY
CIVIL & ENVIRONMENTAL ENGINEERING
Evaluation of Safety Factor for the Design of Earth-Retaining Structures
Compare between GFS Method and PFS Method, abiding AS 4678-2002
Gravity Wall
Cantilever Wall
Embedded Wall
Anchored Wall
Surcharge Loading
Front Face
Back Face
Backfill Soil
Toe
Heel
Foundation Soil
Uniform Surcharge Loading
Anchor
Soil Layer-1
Soil Layer-2
<< Back
Help
Exit
Autumn Semester 2013
Version 1 - Ye AUNG [Student ID: 11276538]


Evaluation of Factor of Safety of the Earth-Retaining Structures - Embedded Wall
UNIVERSITY OF TECHNOLOGY SYDNEY
Calculation of Factor of Safety: using GFS & PFS models
Analysis: Anchored Wall
<< Back to Menu
Help
Reset
Close
Select
Figure
Inputs
Calculate
Select the Condition:
1 Layer of Soil, USL
1 Layer of Soil, ULL
2 Layers of Soil, USL
2 Layers of Soil, ULL
Inputs
Soil Properties
Soil Layer-1:
Unit weight, γ_{S1} [kN/m^3] 18
Friction angle, ϕ_{S1} [°] 30
Cohesion, c [kPa] = 0 (Cohesionless Soil)
Other Properties
Wall dimensions:
Excavation Height, H [m] 2
Factor of Safety & Surcharge:
Factor of Safety, FS 1.5
Uniform Surcharge, q [kPa] 0
Point of anchor from the top of the wall:
Distance from the top of the wall 1
Inclination of Anchor:
Inclination Angle of the Anchor from the horizontal
30 degrees
Diagram
Uniform Surcharge Loading
Back Face
Front Face
H
Anchor
D
Backfill Soil
Soil Layer-1
Soil Layer-1
Input Messages:
Enter / modify input values
Then press "Calculate"
Fill condition:
Class II (controlled 95%) - PHI=0.90; C=0.75
Structure failure classification:
B (moderate) - PHIn=1.0
A (minimal) - PHIn=1.1
B (moderate) - PHIn=1.0
C (significant) - PHIn = 0.9
Autumn Semester 2013
Version 1 - Ye AUNG [Student ID: 11276538]

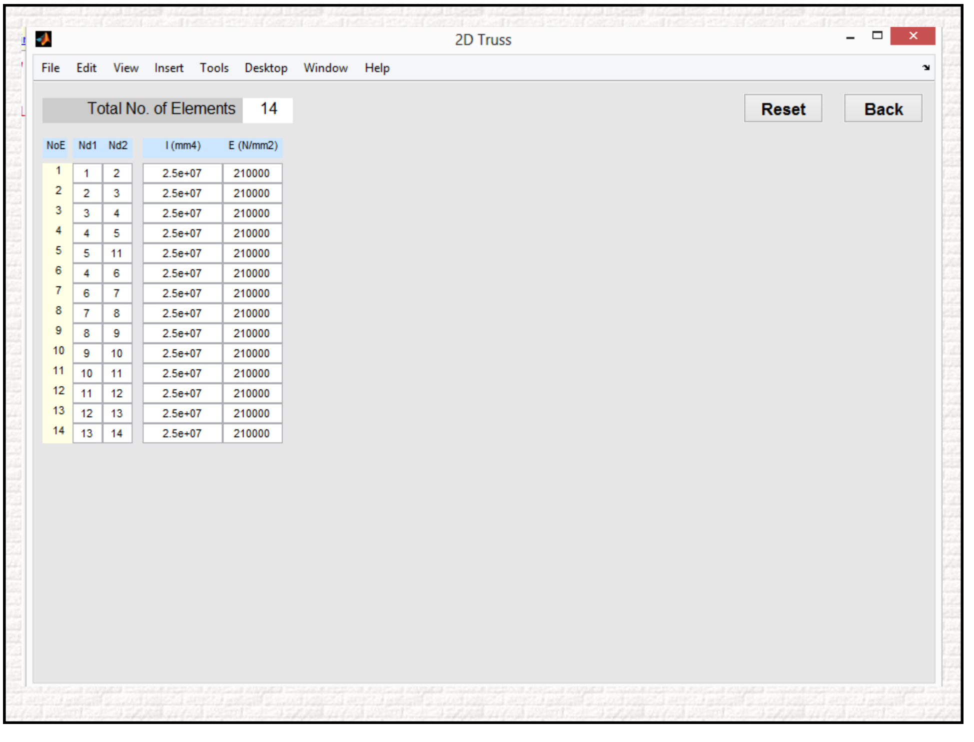

Evaluation of Factor of Safety of the Earth-Retaining Structures - Embedded Wall
UNIVERSITY OF TECHNOLOGY SYDNEY
Calculation of Factor of Safety: using GFS & PFS models
Analysis: Anchored Wall
<< Back to Menu
Help
Reset
Close
Select
Figure
Inputs
Calculate
Results
Output
Key values
Active lateral earth pressure coe: Layer-1
Active lateral earth pressure coe: Layer-2
Passive lateral earth pressure coe: Layer-2
Resultant Active lateral earth force
Resultant Passive lateral earth force
Depth of embeddment
Total Wall Height
Anchor Force
Required Anchor Length
Location of max moment from top
Max moment acting on the wall
GFS
K_{A1} = 0.333
K_{A2} = N/A
K_P = 3.000
F_A [kN] = 8.77
F_P [kN] = 1.52
D [m] = -0.29
H+D [m] = 1.71
A_F [kN] = 7.25
L_A [m] = 0.35
x [m] = 1.55
M_{MAX} [kNm] = 0.26
PFS
K_{A1} = 0.369
K_{A2} = N/A
K_P = 2.711
F_A [kN] = 17.13
F_P [kN] = 1.47
D [m] = -0.27
H+D [m] = 1.73
A_F [kN] = 15.66
L_A [m] = 0.38
x [m] = 1.64
M_{MAX} [kNm] = 0.20
Graph
GFS & PFS Comparisons
Embedment Depth
Anchor Force
Anchor Length
Method
Decision
Incorporated Factor of Safety = 1.50
This factor of safety is used in the analysis using GFS method.
Maximum Moment (GFS) = 0.26
Maximum Moment (PFS) = 0.20
The designer can easily determine the minimum section modulus for the steel sheet-pile wall by simply dividing the maximum moment by the allowable flexural stress of steel.
Autumn Semester 2013
Version 1 - Ye AUNG [Student ID: 11276538]

Structural Engineering

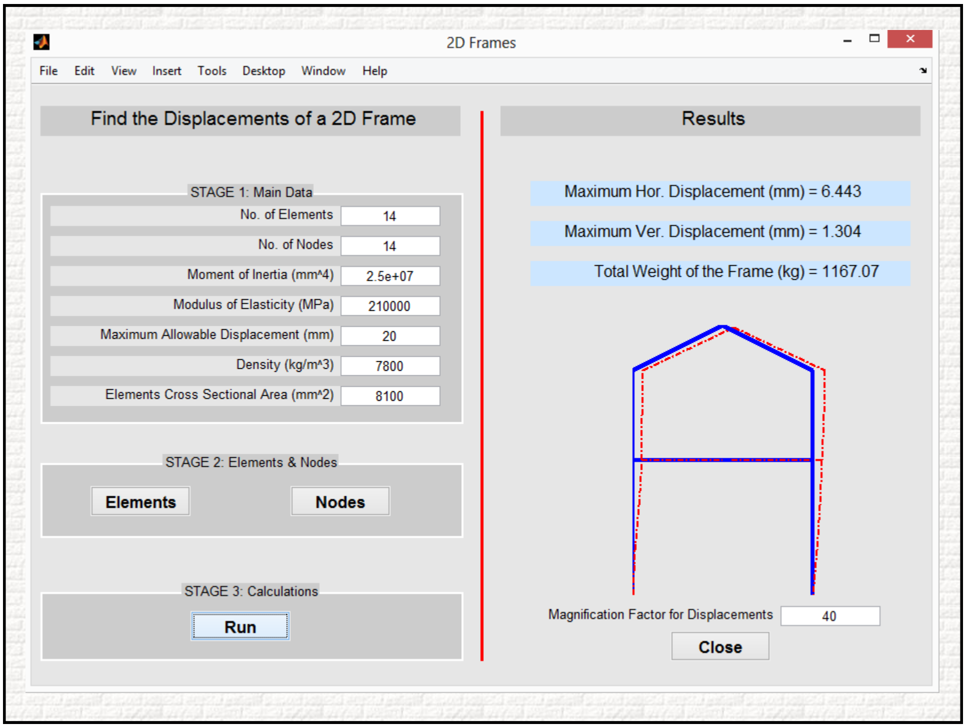


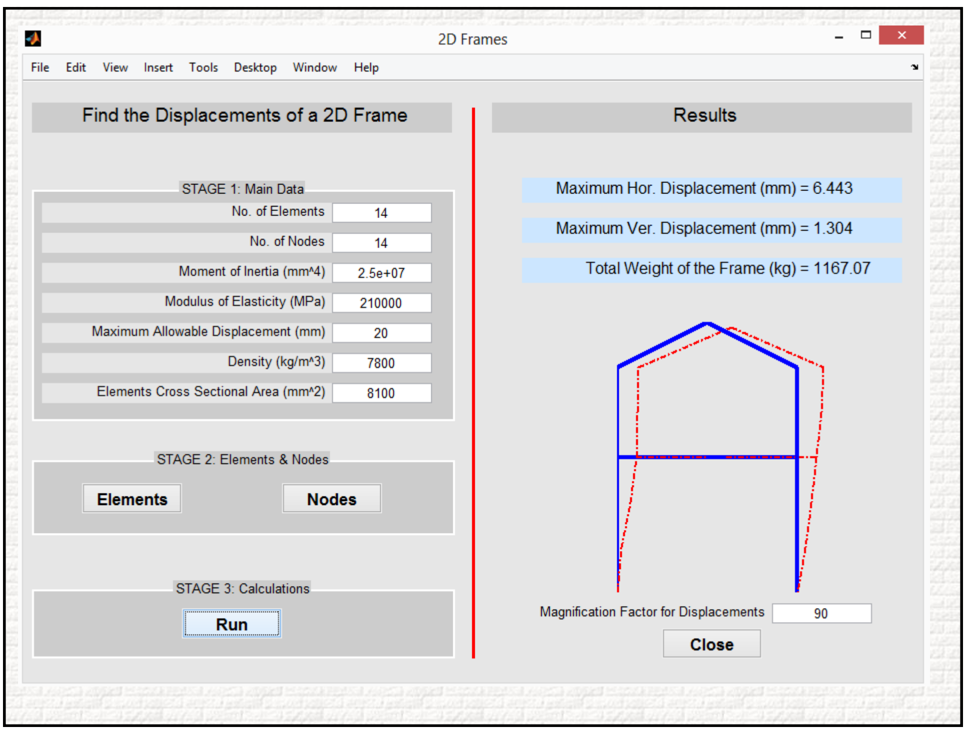


Node	x(mm)	y(mm)	Fx(kN)	Fy(kN)	M(kNm)	Dx	Dy	Dm
1	0	0	0	0	0	0	0	0
2	0	1000	0	0	0	1	1	1
3	0	2000	0	0	0	1	1	1
4	0	3000	0	0	0	1	1	1
5	2000	3000	10	0	0	1	1	1
6	0	4000	0	0	0	1	1	1
7	0	5000	0	0	0	1	1	1
8	2000	6000	0	-20	0	1	1	1
9	4000	5000	0	-5	0	1	1	1
10	4000	4000	0	0	0	1	1	1
11	4000	3000	0	0	0	1	1	1
12	4000	2000	0	0	0	1	1	1
13	4000	1000	0	0	0	1	1	1
14	4000	0	0	0	0	0	0	1

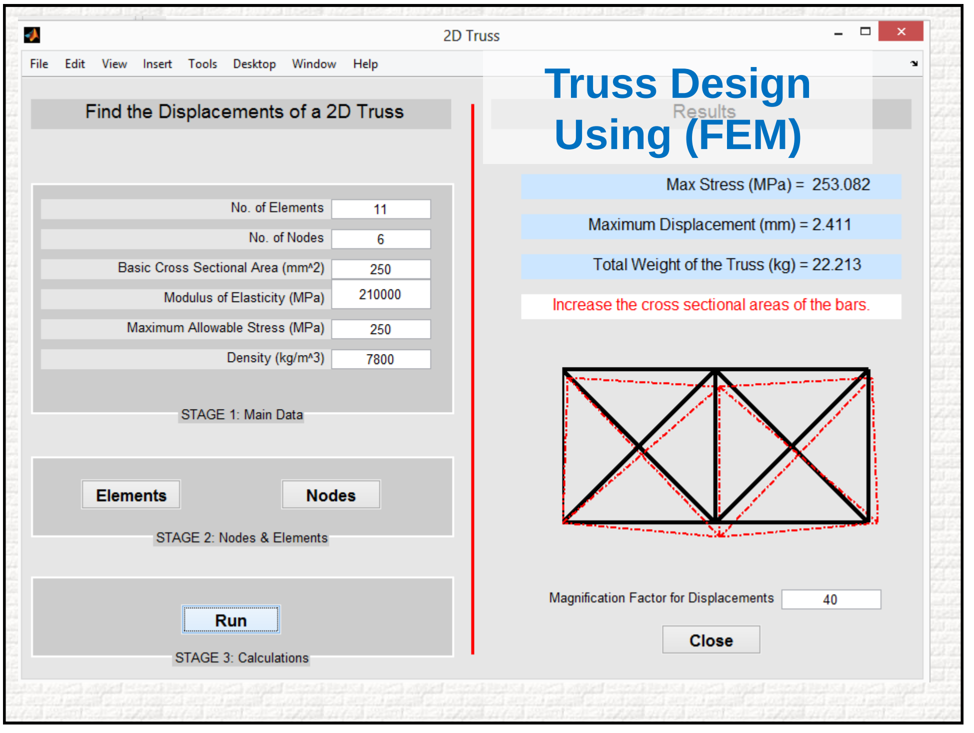


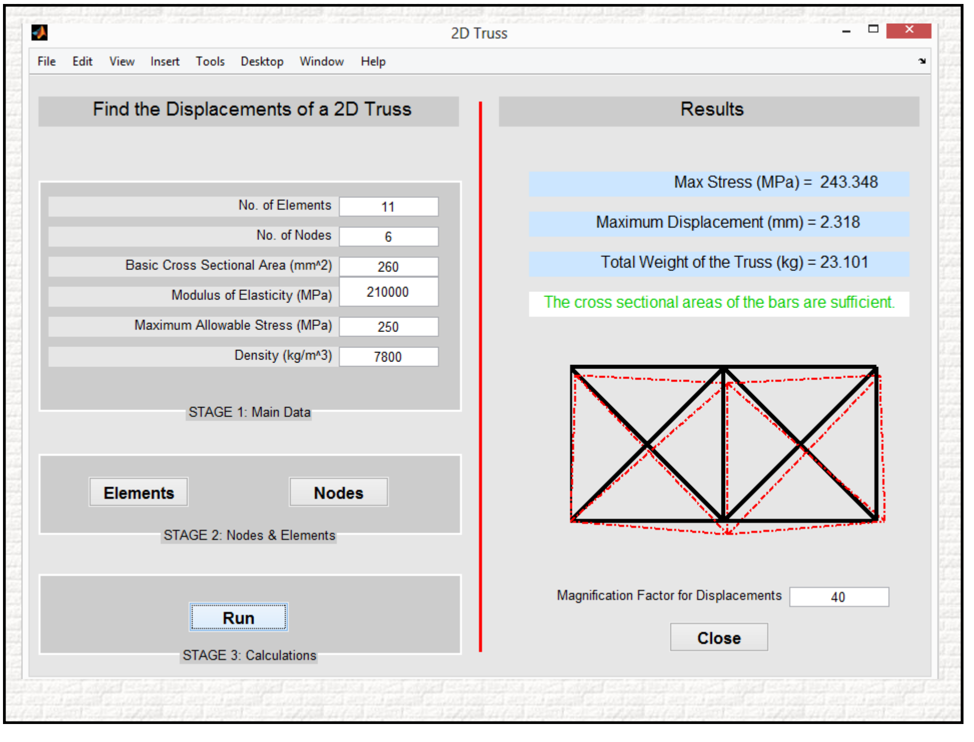
NoE	Nd1	Nd2	I (mm4)	E (N/mm2)
1	1	2	2.5e+07	210000
2	2	3	2.5e+07	210000
3	3	4	2.5e+07	210000
4	4	5	2.5e+07	210000
5	5	11	2.5e+07	210000
6	4	6	2.5e+07	210000
7	6	7	2.5e+07	210000
8	7	8	2.5e+07	210000
9	8	9	2.5e+07	210000
10	9	10	2.5e+07	210000
11	10	11	2.5e+07	210000
12	11	12	2.5e+07	210000
13	12	13	2.5e+07	210000
14	13	14	2.5e+07	210000

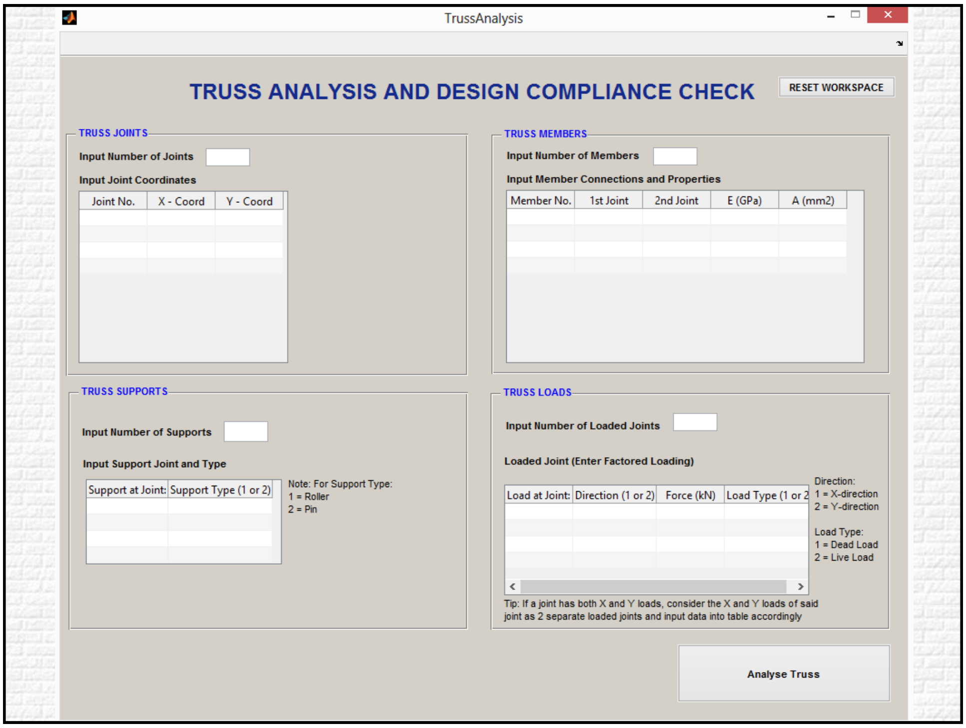

2D Frames
File Edit View Insert Tools Desktop Window Help
Find the Displacements of a 2D Frame
Results
STAGE 1: Main Data
No. of Elements 14
No. of Nodes 14
Moment of Inertia (mm^4) 2.5e+07
Modulus of Elasticity (MPa) 210000
Maximum Allowable Displacement (mm) 20
Density (kg/m^3) 7800
Elements Cross Sectional Area (mm^2) 8100
STAGE 2: Elements & Nodes
Elements
Nodes
STAGE 3: Calculations
Run
Maximum Hor. Displacement (mm) = 6.443
Maximum Ver. Displacement (mm) = 1.304
Total Weight of the Frame (kg) = 1167.07
Magnification Factor for Displacements 40
Close

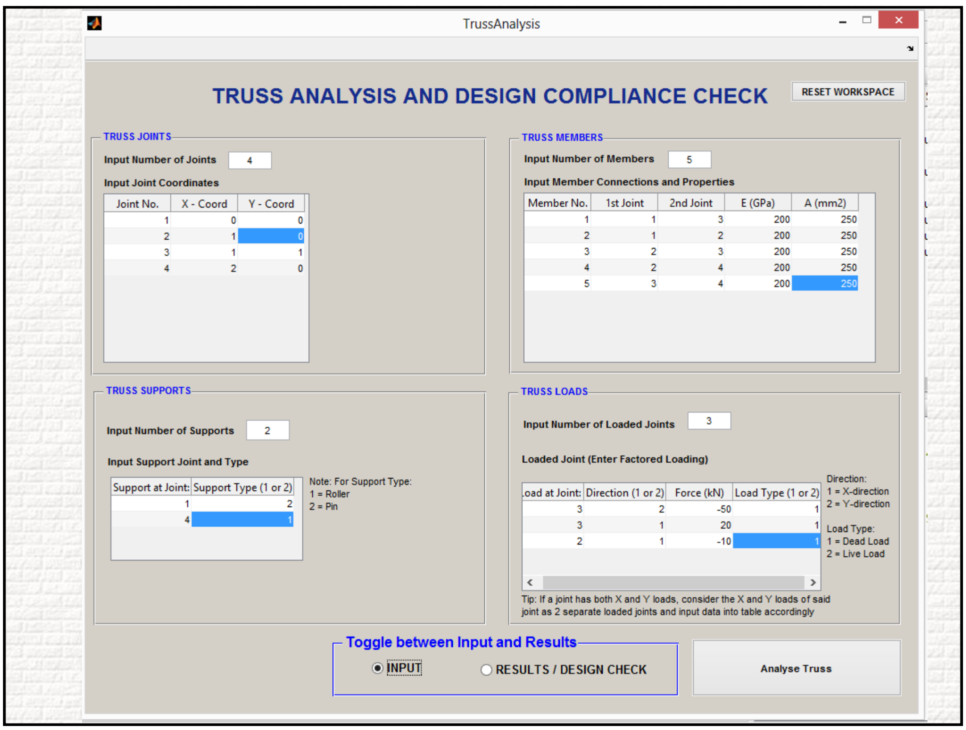

2D Frames
File Edit View Insert Tools Desktop Window Help
Find the Displacements of a 2D Frame
Results
STAGE 1: Main Data
No. of Elements 14
No. of Nodes 14
Moment of Inertia (mm^4) 2.5e+07
Modulus of Elasticity (MPa) 210000
Maximum Allowable Displacement (mm) 20
Density (kg/m^3) 7800
Elements Cross Sectional Area (mm^2) 8100
STAGE 2: Elements & Nodes
Elements
Nodes
STAGE 3: Calculations
Run
Maximum Hor. Displacement (mm) = 6.443
Maximum Ver. Displacement (mm) = 1.304
Total Weight of the Frame (kg) = 1167.07
Magnification Factor for Displacements 90
Close

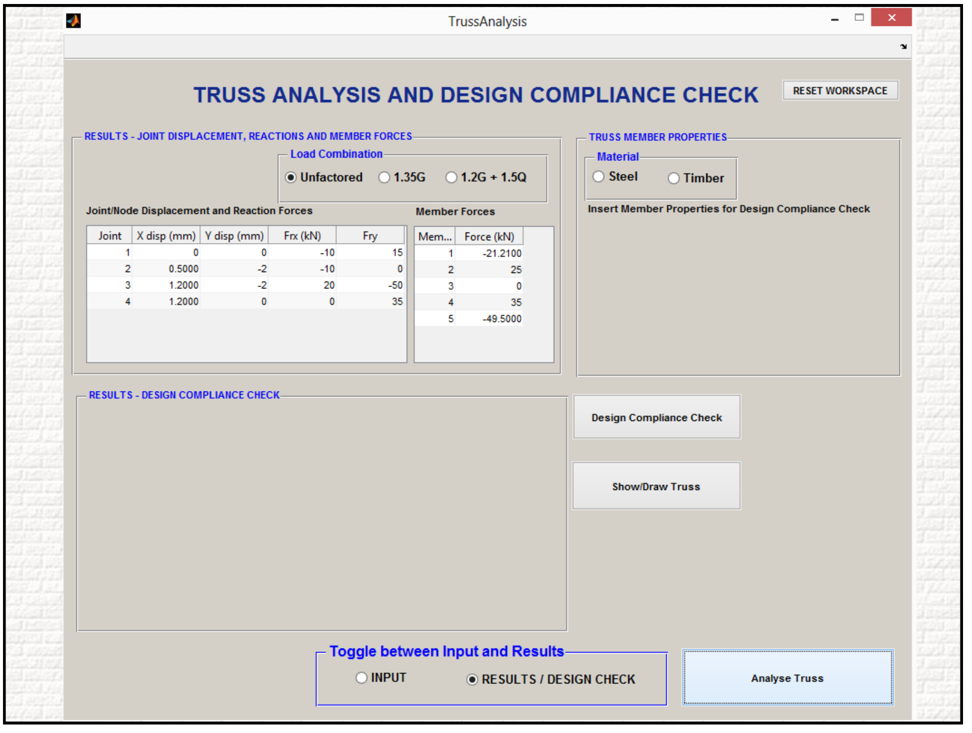
Truss Design Using (FEM)

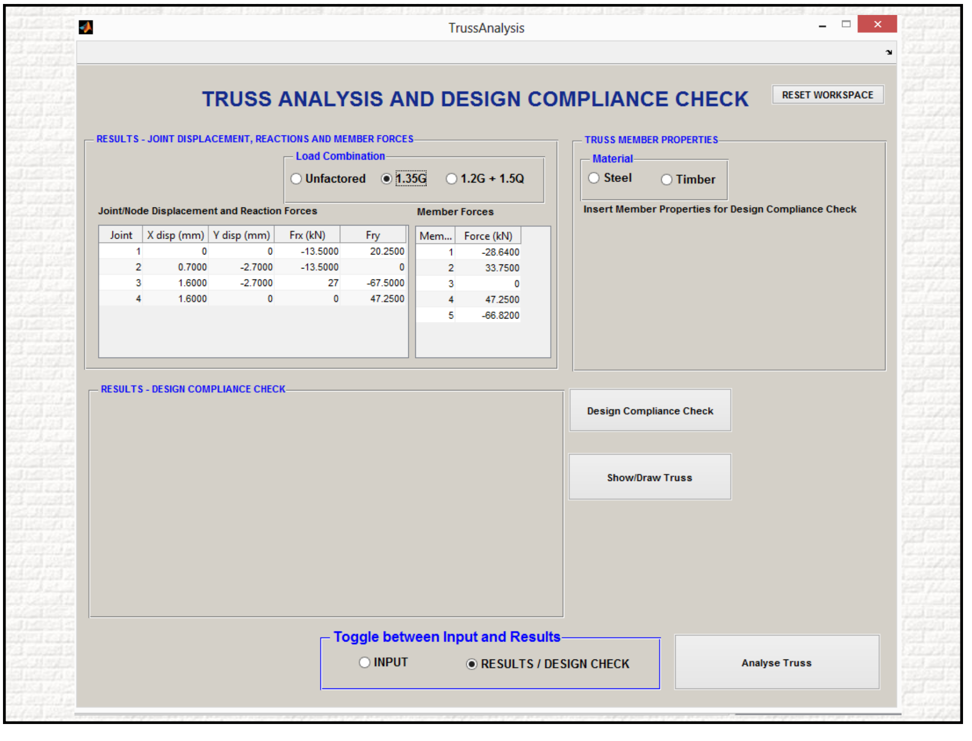


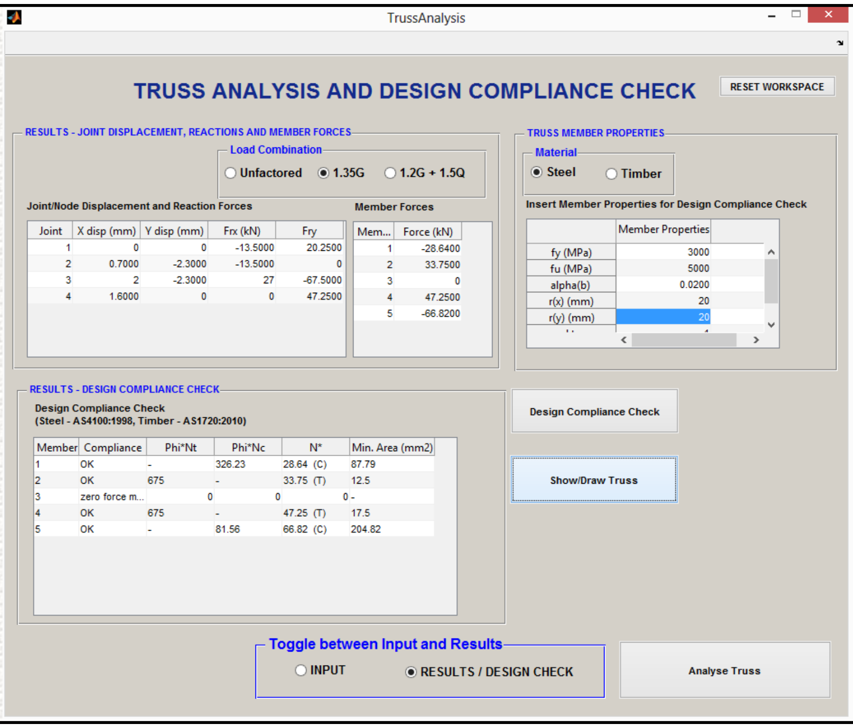



TrussAnalysis
TRUSS ANALYSIS AND DESIGN COMPLIANCE CHECK
RESET WORKSPACE
TRUSS JOINTS
Input Number of Joints
Input Joint Coordinates
Joint No. X - Coord Y - Coord
TRUSS MEMBERS
Input Number of Members
Input Member Connections and Properties
Member No. 1st Joint 2nd Joint E (GPa) A (mm2)
TRUSS SUPPORTS
Input Number of Supports
Input Support Joint and Type
Support at Joint Support Type (1 or 2)
Note: For Support Type:
1 = Roller
2 = Pin
TRUSS LOADS
Input Number of Loaded Joints
Loaded Joint (Enter Factored Loading)
Load at Joint Direction (1 or 2) Force (kN) Load Type (1 or 2
Direction:
1 = X-direction
2 = Y-direction
Load Type:
1 = Dead Load
2 = Live Load
Tip: If a joint has both X and Y loads, consider the X and Y loads of said joint as 2 separate loaded joints and input data into table accordingly
Analyse Truss

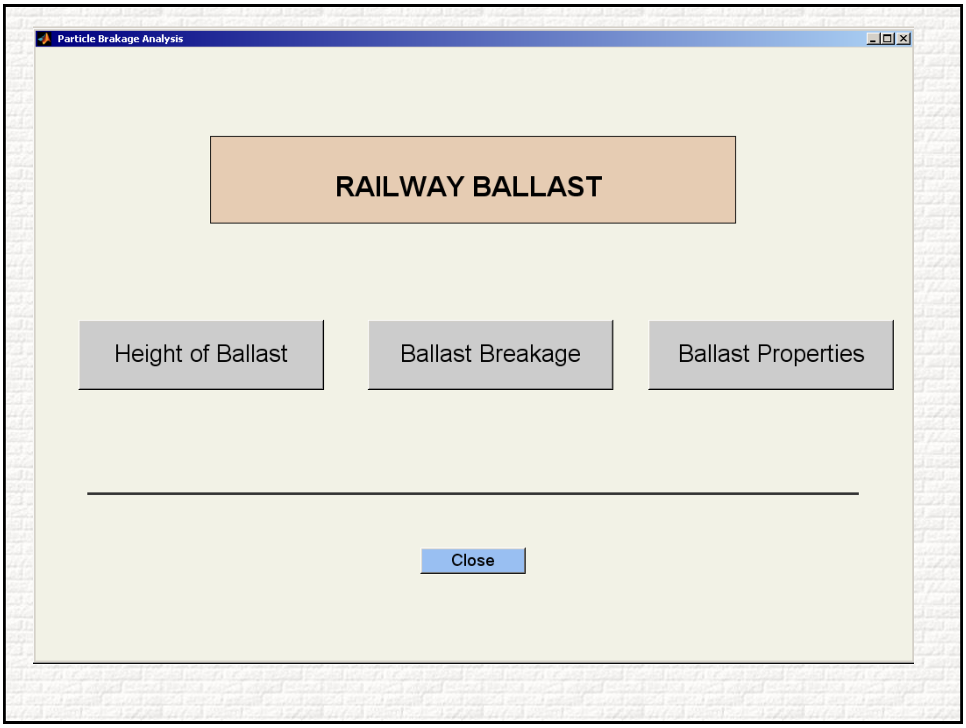

TrussAnalysis
TRUSS ANALYSIS AND DESIGN COMPLIANCE CHECK
RESET WORKSPACE
TRUSS JOINTS
Input Number of Joints 4
Input Joint Coordinates
Joint No. X - Coord Y - Coord
1 0 0
2 1 0
3 1 1
4 2 0
TRUSS MEMBERS
Input Number of Members 5
Input Member Connections and Properties
Member No. 1st Joint 2nd Joint E (GPa) A (mm2)
1 1 3 200 250
2 1 2 200 250
3 2 3 200 250
4 2 4 200 250
5 3 4 200 250
TRUSS SUPPORTS
Input Number of Supports 2
Input Support Joint and Type
Support at Joint Support Type (1 or 2)
1 2
4 1
Note: For Support Type:
1 = Roller
2 = Pin
TRUSS LOADS
Input Number of Loaded Joints 3
Loaded Joint (Enter Factored Loading)
oad at Joint Direction (1 or 2) Force (kN) Load Type (1 or 2)
3 2 -50 1
3 1 20 1
2 1 -10 1
Direction:
1 = X-direction
2 = Y-direction
Load Type:
1 = Dead Load
2 = Live Load
Tip: If a joint has both X and Y loads, consider the X and Y loads of said joint as 2 separate loaded joints and input data into table accordingly
Toggle between Input and Results
INPUT
RESULTS / DESIGN CHECK
Analyse Truss

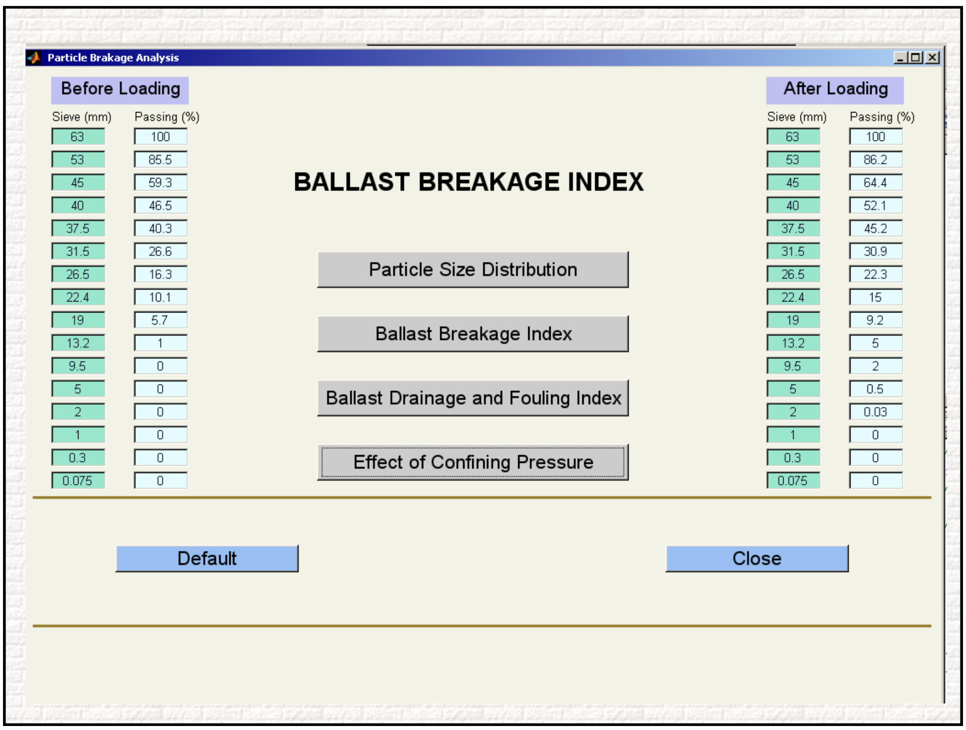

TrussAnalysis
TRUSS ANALYSIS AND DESIGN COMPLIANCE CHECK
RESET WORKSPACE
RESULTS - JOINT DISPLACEMENT, REACTIONS AND MEMBER FORCES
Load Combination
Unfactored
1.35G
1.2G + 1.5Q
Joint/Node Displacement and Reaction Forces
Joint | X disp (mm) | Y disp (mm) | Frx (kN) | Fry
1 | 0 | 0 | -10 | 15
2 | 0.5000 | -2 | -10 | 0
3 | 1.2000 | -2 | 20 | -50
4 | 1.2000 | 0 | 0 | 35
Member Forces
Mem... | Force (kN)
1 | -21.2100
2 | 25
3 | 0
4 | 35
5 | -49.5000
TRUSS MEMBER PROPERTIES
Material
Steel
Timber
Insert Member Properties for Design Compliance Check
RESULTS - DESIGN COMPLIANCE CHECK
Design Compliance Check
Show/Draw Truss
Toggle between Input and Results
INPUT
RESULTS / DESIGN CHECK
Analyse Truss

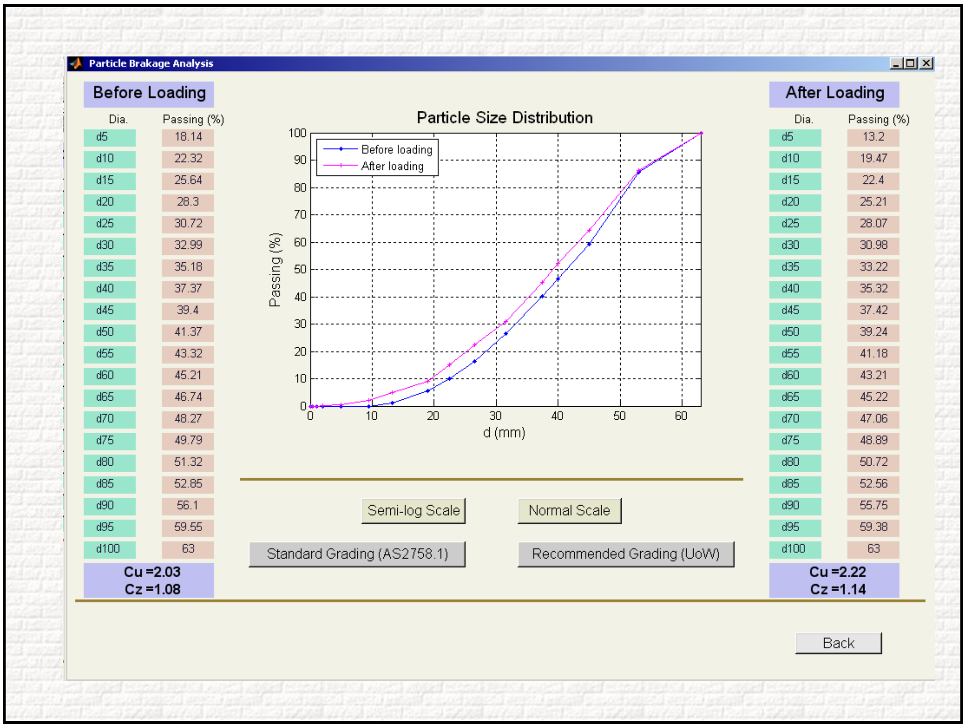

TrussAnalysis
TRUSS ANALYSIS AND DESIGN COMPLIANCE CHECK
RESET WORKSPACE
RESULTS - JOINT DISPLACEMENT, REACTIONS AND MEMBER FORCES
Load Combination
Unfactored
1.35G
1.2G + 1.5Q
Joint/Node Displacement and Reaction Forces
Joint | X disp (mm) | Y disp (mm) | Frx (kN) | Fry
1 | 0 | 0 | -13.5000 | 20.2500
2 | 0.7000 | -2.7000 | -13.5000 | 0
3 | 1.6000 | -2.7000 | 27 | -67.5000
4 | 1.6000 | 0 | 0 | 47.2500
Member Forces
Mem... | Force (kN)
1 | -28.6400
2 | 33.7500
3 | 0
4 | 47.2500
5 | -66.8200
TRUSS MEMBER PROPERTIES
Material
Steel
Timber
Insert Member Properties for Design Compliance Check
RESULTS - DESIGN COMPLIANCE CHECK
Design Compliance Check
Show/Draw Truss
Toggle between Input and Results
INPUT
RESULTS / DESIGN CHECK
Analyse Truss



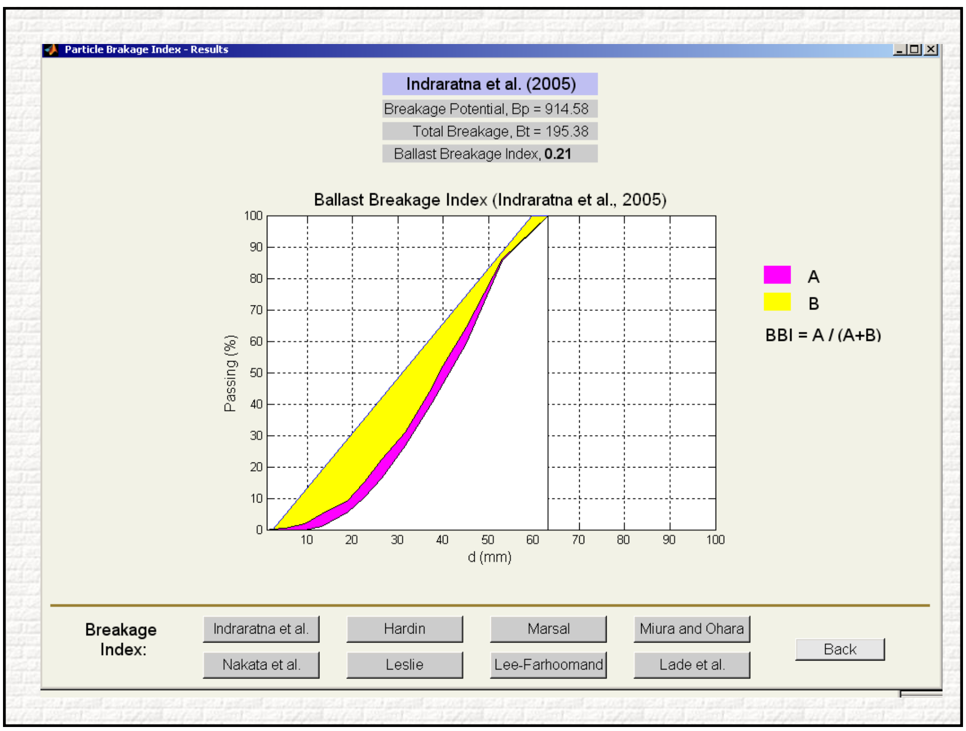
Railway Engineering


Particle Brakage Analysis
RAILWAY BALLAST
Height of Ballast
Ballast Breakage
Ballast Properties
Close

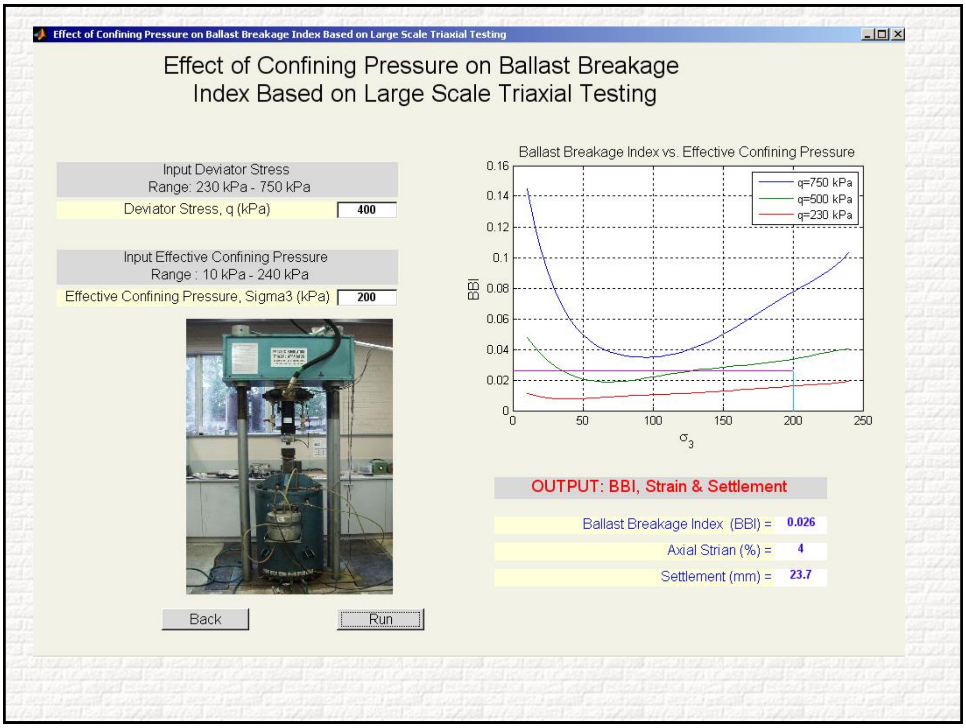

Particle Brakage Analysis
Before Loading
Sieve (mm)
Passing (%)
63 100
53 85.5
45 59.3
40 46.5
37.5 40.3
31.5 26.6
26.5 16.3
22.4 10.1
19 5.7
13.2 1
9.5 0
5 0
2 0
1 0
0.3 0
0.075 0
BALLAST BREAKAGE INDEX
Particle Size Distribution
Ballast Breakage Index
Ballast Drainage and Fouling Index
Effect of Confining Pressure
After Loading
Sieve (mm)
Passing (%)
63 100
53 86.2
45 64.4
40 52.1
37.5 45.2
31.5 30.9
26.5 22.3
22.4 15
19 9.2
13.2 5
9.5 2
5 0.5
2 0.03
1 0
0.3 0
0.075 0
Default
Close

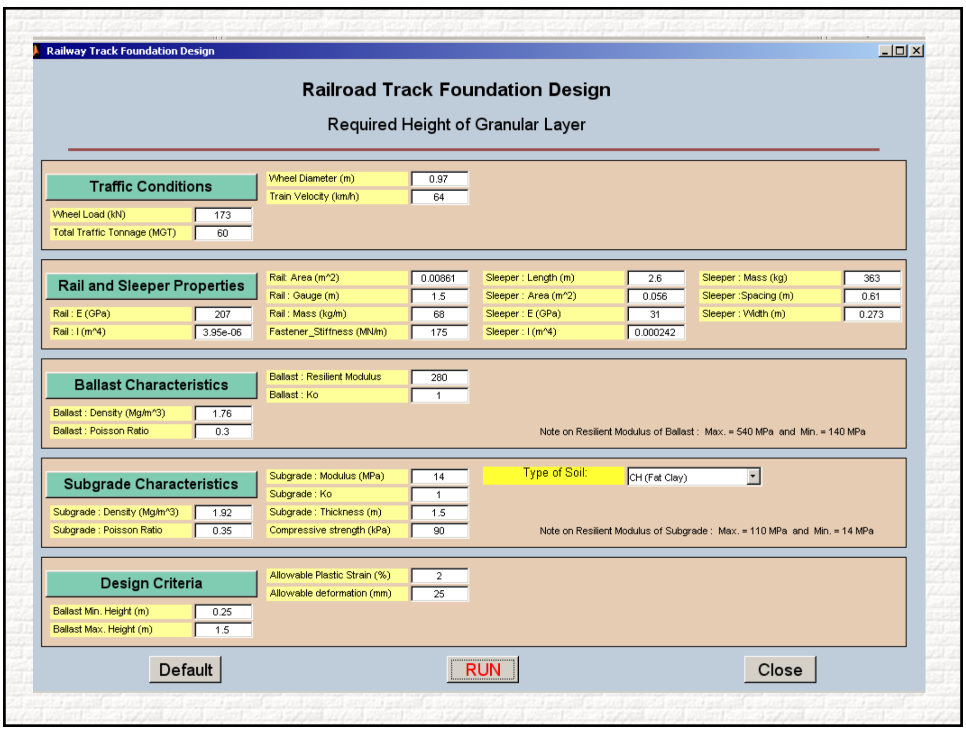


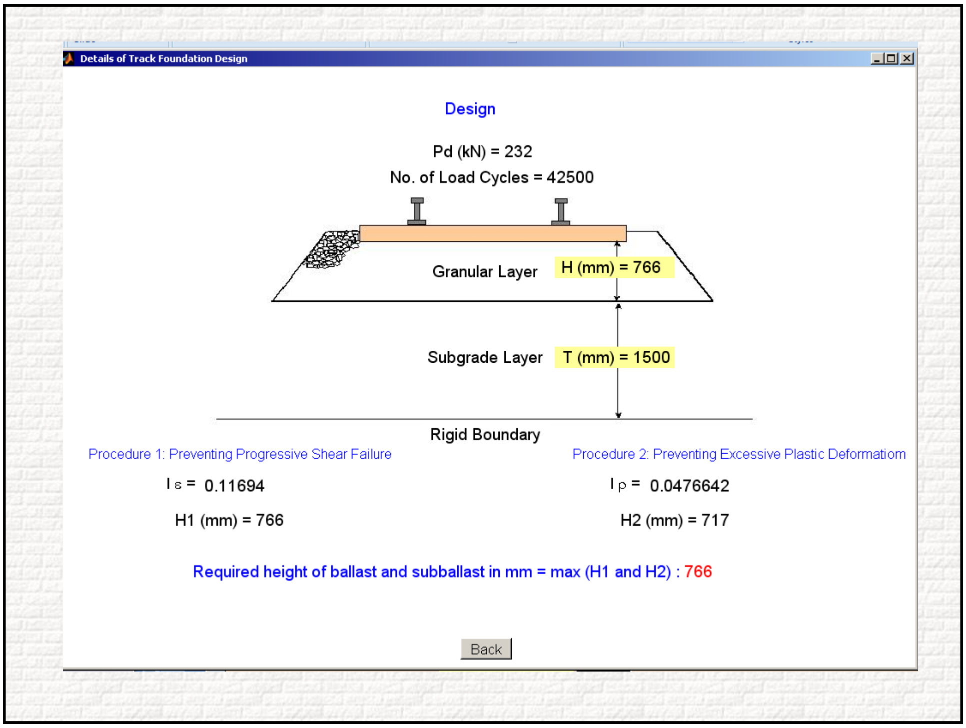
Particle Brakage Analysis
Before Loading
Dia. Passing (%)
d5 18.14
d10 22.32
d15 25.64
d20 28.3
d25 30.72
d30 32.99
d35 35.18
d40 37.37
d45 39.4
d50 41.37
d55 43.32
d60 45.21
d65 46.74
d70 48.27
d75 49.79
d80 51.32
d85 52.85
d90 56.1
d95 59.55
d100 63
Cu =2.03
Cz =1.08
Particle Size Distribution
Before loading
After loading
Passing (%)
d (mm)
Semi-log Scale
Normal Scale
Standard Grading (AS2758.1)
Recommended Grading (UoW)
After Loading
Dia. Passing (%)
d5 13.2
d10 19.47
d15 22.4
d20 25.21
d25 28.07
d30 30.98
d35 33.22
d40 35.32
d45 37.42
d50 39.24
d55 41.18
d60 43.21
d65 45.22
d70 47.06
d75 48.89
d80 50.72
d85 52.56
d90 55.75
d95 59.38
d100 63
Cu =2.22
Cz =1.14
Back



Particle Brakage Index - Results
Indraratna et al. (2005)
Breakage Potential, Bp = 914.58
Total Breakage, Bt = 195.38
Ballast Breakage Index, 0.21
Ballast Breakage Index (Indraratna et al., 2005)
Passing (%)
d (mm)
A
B
BBI = A / (A+B)
Breakage Index:
Indraratna et al.
Hardin
Marsal
Miura and Ohara
Nakata et al.
Leslie
Lee-Farhoomand
Lade et al.
Back


Effect of Confining Pressure on Ballast Breakage Index Based on Large Scale Triaxial Testing
Effect of Confining Pressure on Ballast Breakage Index Based on Large Scale Triaxial Testing
Input Deviator Stress
Range: 230 kPa - 750 kPa
Deviator Stress, q (kPa) 400
Input Effective Confining Pressure
Range : 10 kPa - 240 kPa
Effective Confining Pressure, Sigma3 (kPa) 200
Ballast Breakage Index vs. Effective Confining Pressure
q=750 kPa
q=500 kPa
q=230 kPa
BBI
σ3
OUTPUT: BBI, Strain & Settlement
Ballast Breakage Index (BBI) = 0.026
Axial Strian (%) = 4
Settlement (mm) = 23.7
Back
Run


Railway Track Foundation Design
Railroad Track Foundation Design
Required Height of Granular Layer
Traffic Conditions
Wheel Diameter (m) 0.97
Train Velocity (km/h) 64
Wheel Load (kN) 173
Total Traffic Tonnage (MGT) 60
Rail and Sleeper Properties
Rail: Area (m^2) 0.00861
Rail : Gauge (m) 1.5
Rail : Mass (kg/m) 68
Fastener_Stiffness (MN/m) 175
Sleeper : Length (m) 2.6
Sleeper : Area (m^2) 0.056
Sleeper : E (GPa) 31
Sleeper : I (m^4) 0.000242
Sleeper : Mass (kg) 363
Sleeper :Spacing (m) 0.61
Sleeper : Width (m) 0.273
Rail : E (GPa) 207
Rail : I (m^4) 3.95e-06
Ballast Characteristics
Ballast : Resilient Modulus 280
Ballast : Ko 1
Ballast : Density (Mg/m^3) 1.76
Ballast : Poisson Ratio 0.3
Note on Resilient Modulus of Ballast : Max. = 540 MPa and Min. = 140 MPa
Subgrade Characteristics
Subgrade : Modulus (MPa) 14
Subgrade : Ko 1
Subgrade : Thickness (m) 1.5
Compressive strength (kPa) 90
Type of Soil: CH (Fat Clay)
Subgrade : Density (Mg/m^3) 1.92
Subgrade : Poisson Ratio 0.35
Note on Resilient Modulus of Subgrade : Max. = 110 MPa and Min. = 14 MPa
Design Criteria
Allowable Plastic Strain (%) 2
Allowable deformation (mm) 25
Ballast Min. Height (m) 0.25
Ballast Max. Height (m) 1.5
Default
RUN
Close



Conclusions

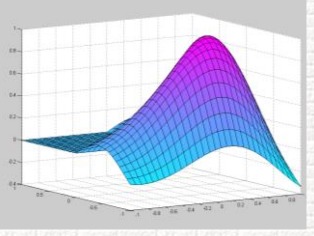
MATLAB can be employed in Civil Engineering Education and Design Problems for its:

- **Powerful Graphics**
- **Easy Matrix Operations**
- **Graphical User Interface**
- **Useful Toolboxes**

Conclusions

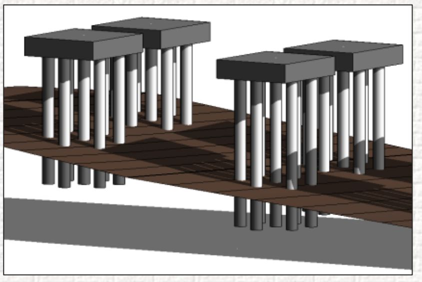
➢ Through the developed codes in MATLAB and the comparison of the results, advantages and disadvantages of different civil engineering design problems and methods can be identified in terms of:

- ❑ Safety,
- ❑ Economy and
- ❑ Design Contexts.

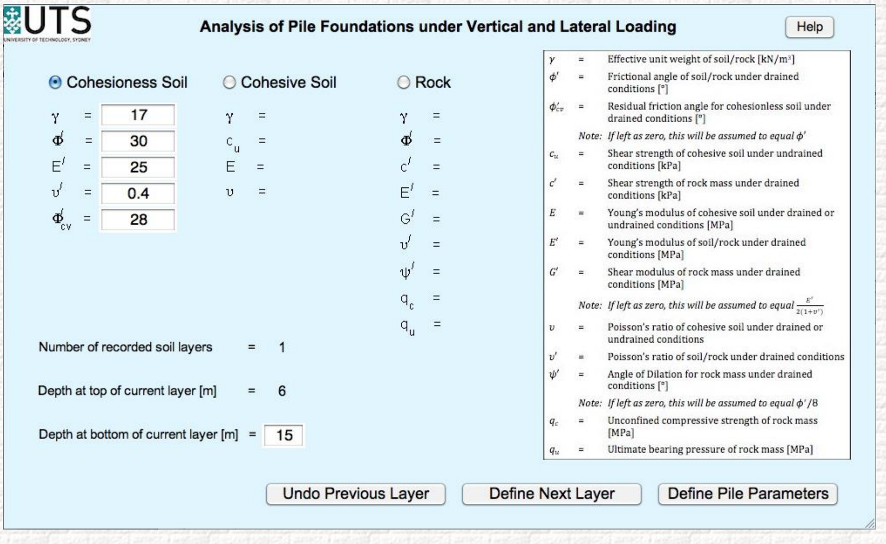


Pile Design

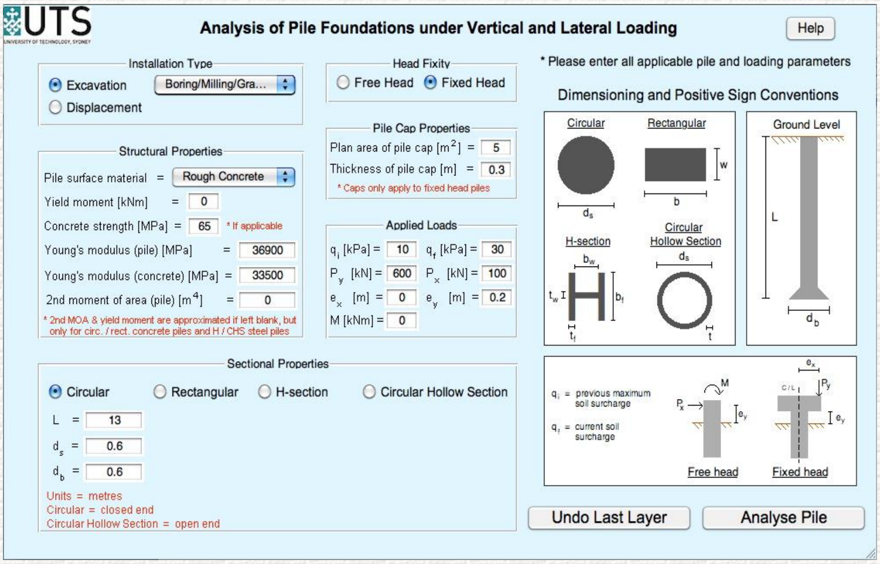
Design and Analysis of Pile Foundations under Vertical and Lateral Loading



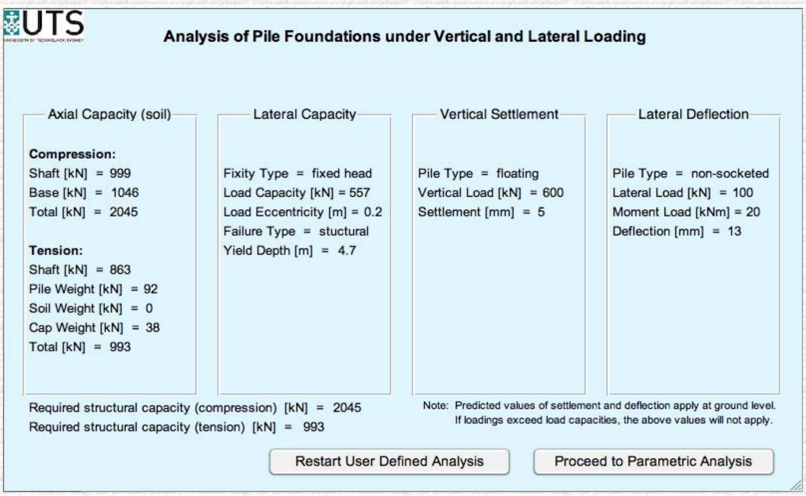
User Defined MATLAB Model for Piles



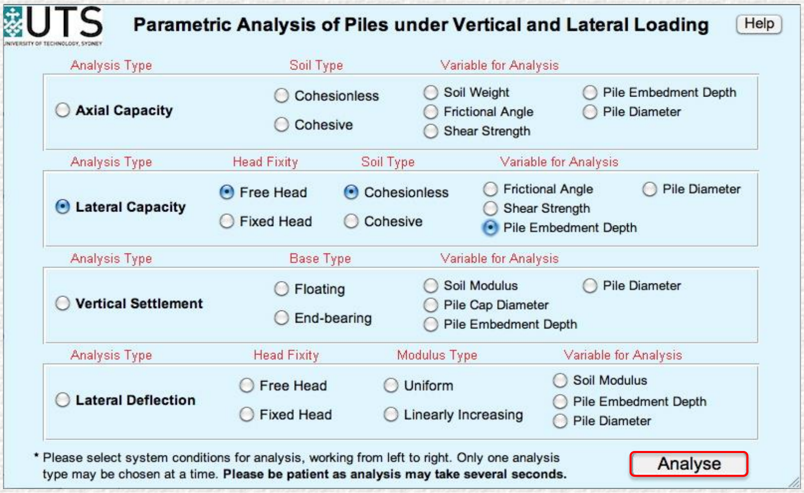
User Defined MATLAB Model



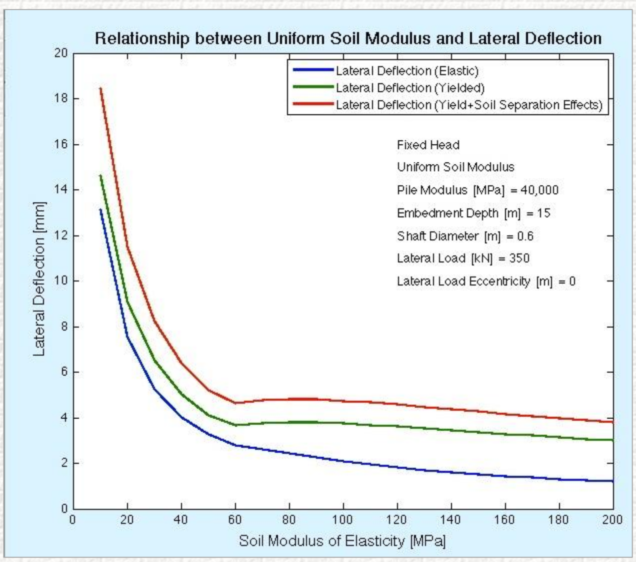
Pile Capacities and Deformations



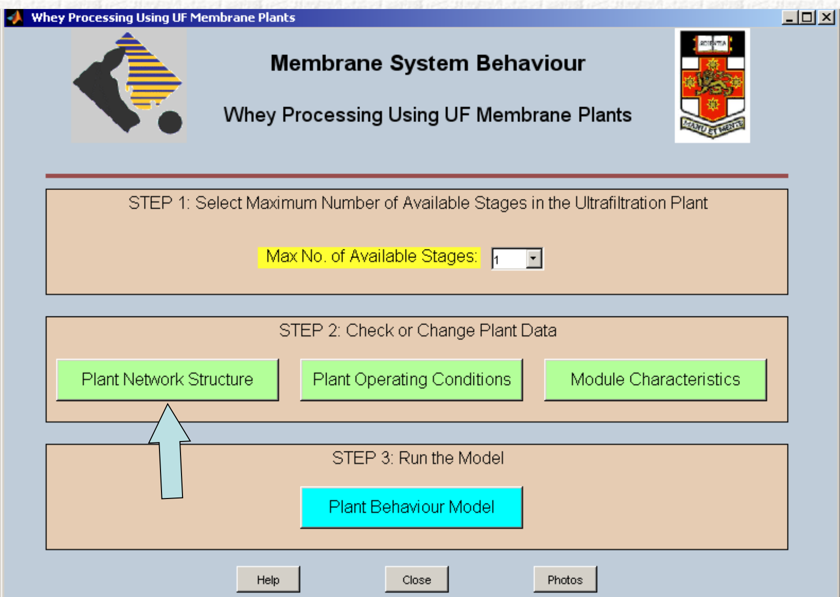
Parametric Studies

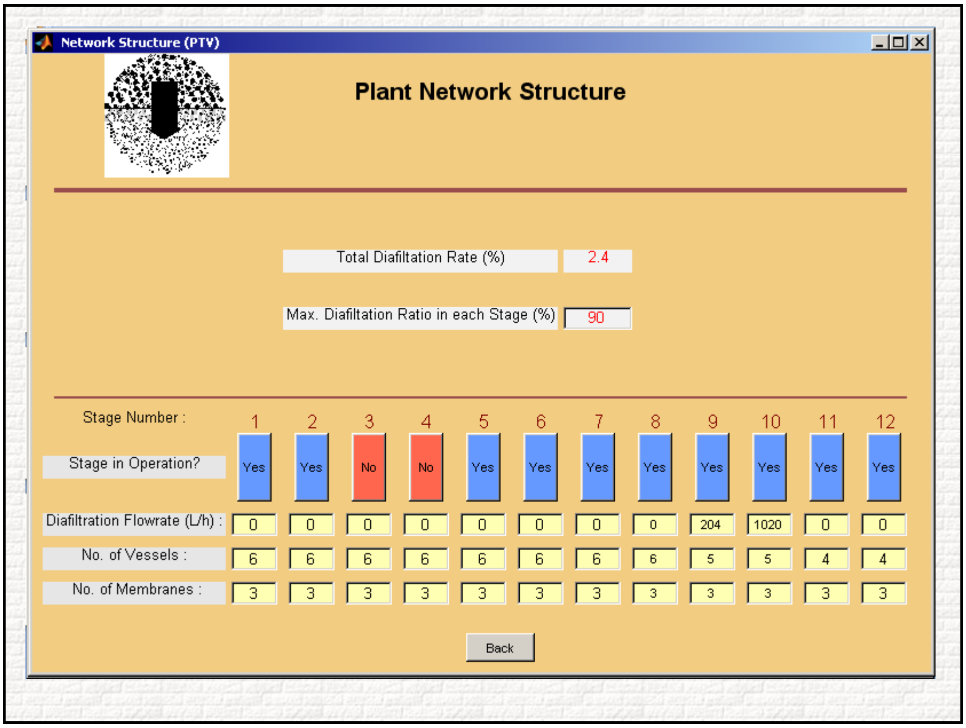


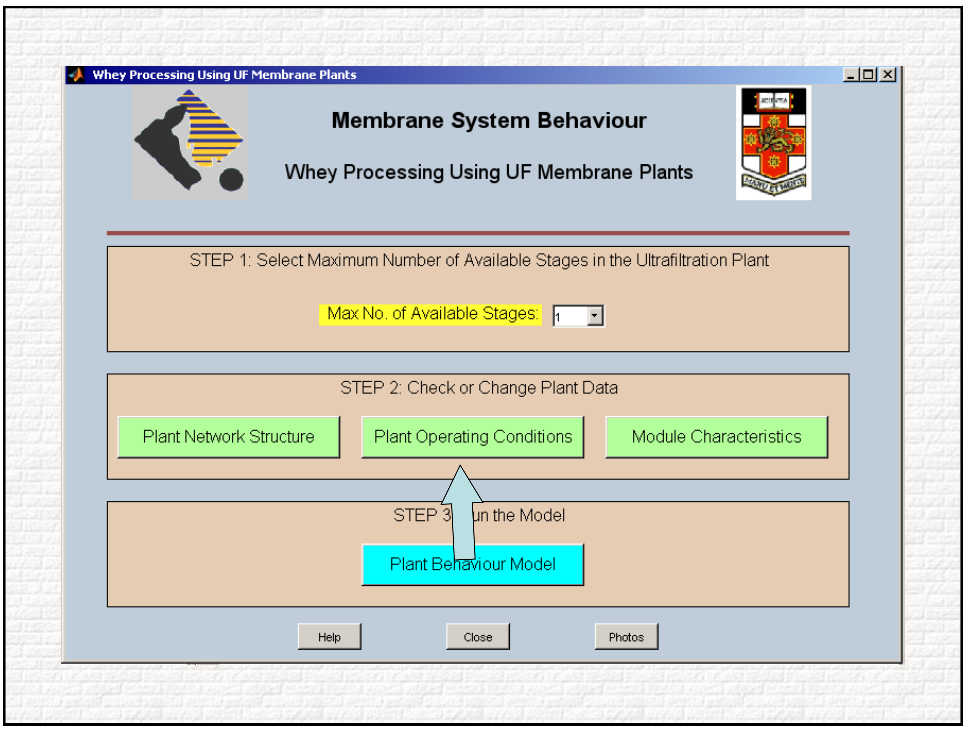
A Sample of Parametric Study Results

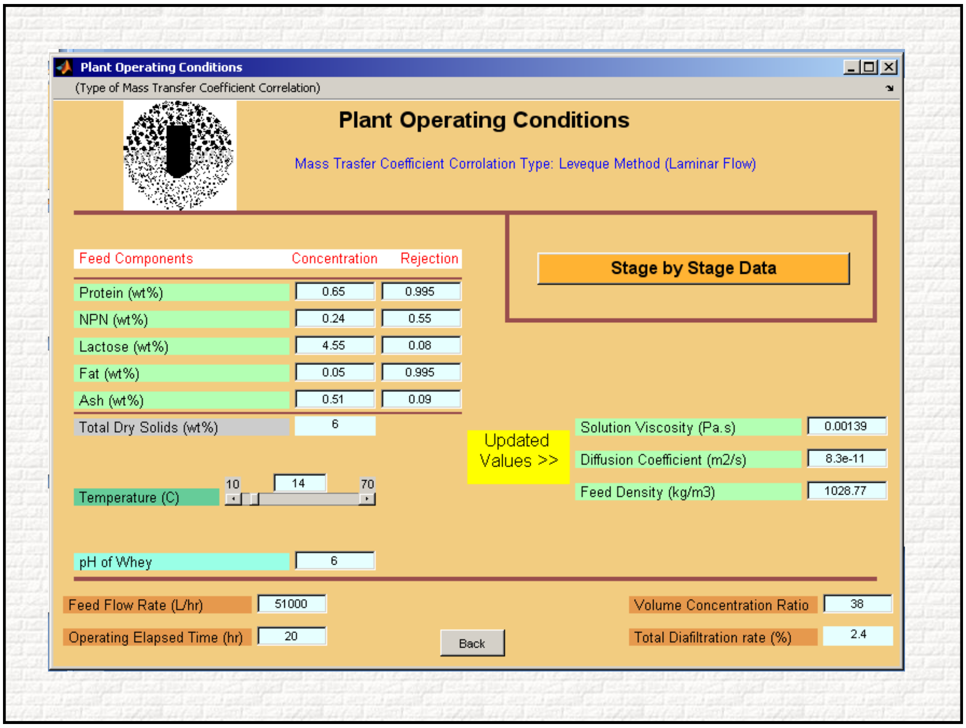


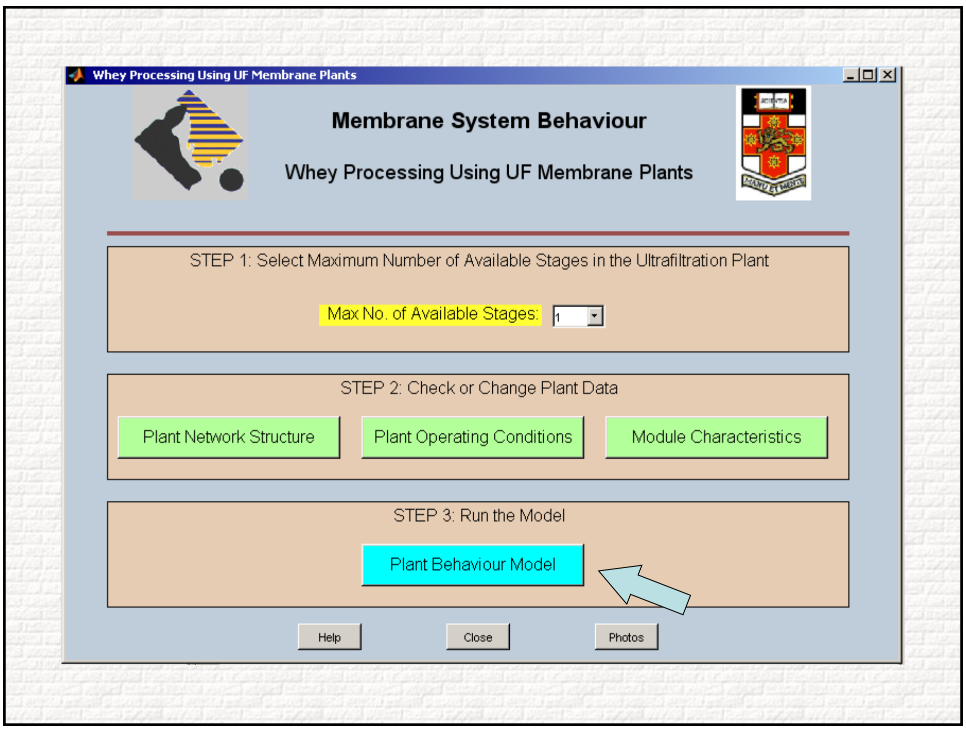
Environmental Engineering

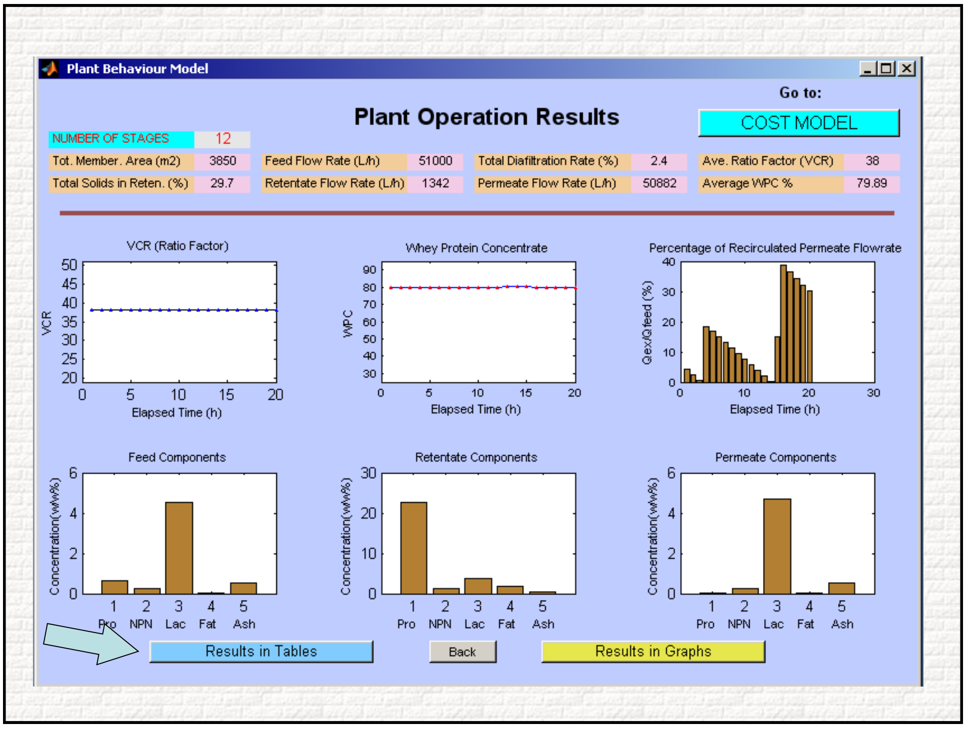


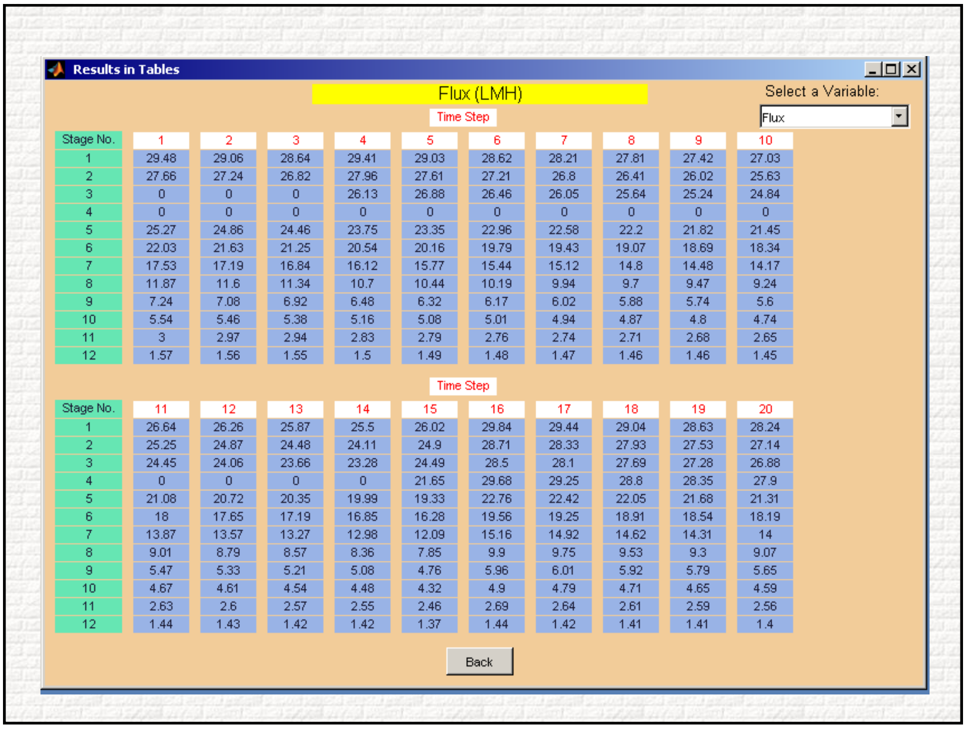

Network Structure (PTV)
Plant Network Structure
Total Diafiltation Rate (%)
2.4
Max. Diafiltation Ratio in each Stage (%)
90
Stage Number :
1 2 3 4 5 6 7 8 9 10 11 12
Stage in Operation?
Yes Yes No No Yes Yes Yes Yes Yes Yes Yes Yes
Diafiltration Flowrate (L/h) :
0 0 0 0 0 0 0 0 204 1020 0 0
No. of Vessels :
6 6 6 6 6 6 6 6 5 5 4 4
No. of Membranes :
3 3 3 3 3 3 3 3 3 3 3 3
Back


Whey Processing Using UF Membrane Plants
Membrane System Behaviour
Whey Processing Using UF Membrane Plants
STEP 1: Select Maximum Number of Available Stages in the Ultrafiltration Plant
Max No. of Available Stages:
1
STEP 2: Check or Change Plant Data
Plant Network Structure
Plant Operating Conditions
Module Characteristics
STEP 3
un the Model
Plant Behaviour Model
Help
Close
Photos


Plant Operating Conditions
(Type of Mass Transfer Coefficient Correlation)
Plant Operating Conditions
Mass Trasfer Coefficient Corrolation Type: Leveque Method (Laminar Flow)
Stage by Stage Data
Feed Components
Concentration
Rejection
Protein (wt%)
0.65
0.995
NPN (wt%)
0.24
0.55
Lactose (wt%)
4.55
0.08
Fat (wt%)
0.05
0.995
Ash (wt%)
0.51
0.09
Total Dry Solids (wt%)
6
Updated Values >>
Solution Viscosity (Pa.s)
0.00139
Diffusion Coefficient (m2/s)
8.3e-11
Feed Density (kg/m3)
1028.77
Temperature (C)
10
14
70
pH of Whey
6
Feed Flow Rate (L/hr)
51000
Operating Elapsed Time (hr)
20
Back
Volume Concentration Ratio
38
Total Diafiltration rate (%)
2.4


Whey Processing Using UF Membrane Plants
Membrane System Behaviour
Whey Processing Using UF Membrane Plants
STEP 1: Select Maximum Number of Available Stages in the Ultrafiltration Plant
Max No. of Available Stages:
1
STEP 2: Check or Change Plant Data
Plant Network Structure
Plant Operating Conditions
Module Characteristics
STEP 3: Run the Model
Plant Behaviour Model
Help
Close
Photos





Results in Tables

Flux (LMH)

Select a Variable: Flux

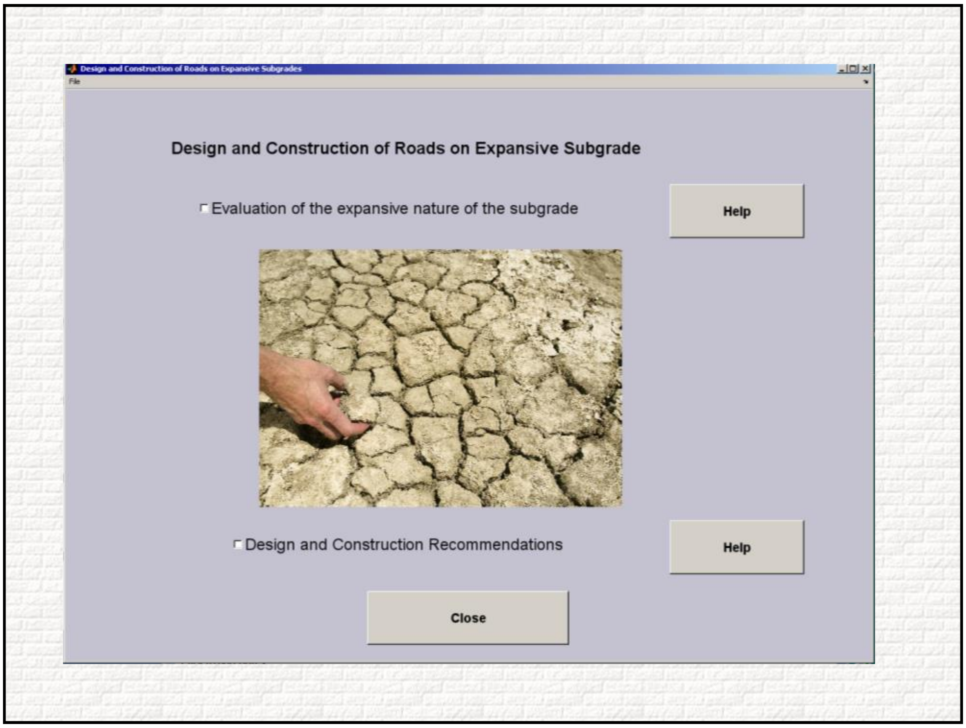
Time Step

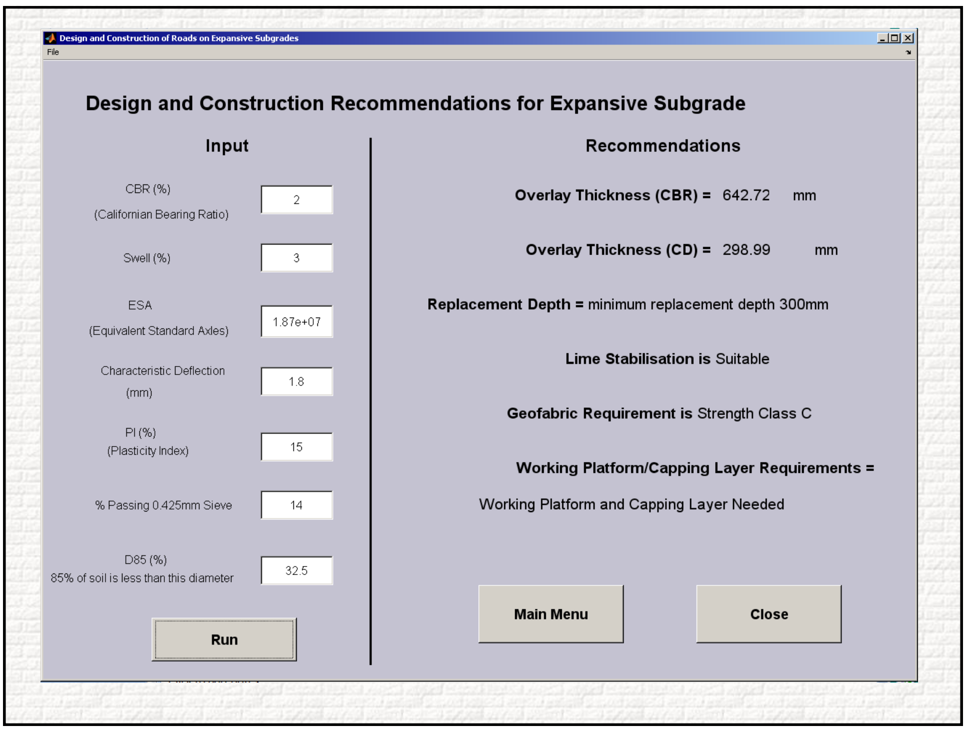
Stage No.	1	2	3	4	5	6	7	8	9	10
1	29.48	29.06	28.64	29.41	29.03	28.62	28.21	27.81	27.42	27.03
2	27.66	27.24	26.82	27.96	27.61	27.21	26.8	26.41	26.02	25.63
3	0	0	0	26.13	26.88	26.46	26.05	25.64	25.24	24.84
4	0	0	0	0	0	0	0	0	0	0
5	25.27	24.86	24.46	23.75	23.35	22.96	22.58	22.2	21.82	21.45
6	22.03	21.63	21.25	20.54	20.16	19.79	19.43	19.07	18.69	18.34
7	17.53	17.19	16.84	16.12	15.77	15.44	15.12	14.8	14.48	14.17
8	11.87	11.6	11.34	10.7	10.44	10.19	9.94	9.7	9.47	9.24
9	7.24	7.08	6.92	6.48	6.32	6.17	6.02	5.88	5.74	5.6
10	5.54	5.46	5.38	5.16	5.08	5.01	4.94	4.87	4.8	4.74
11	3	2.97	2.94	2.83	2.79	2.76	2.74	2.71	2.68	2.65
12	1.57	1.56	1.55	1.5	1.49	1.48	1.47	1.46	1.46	1.45

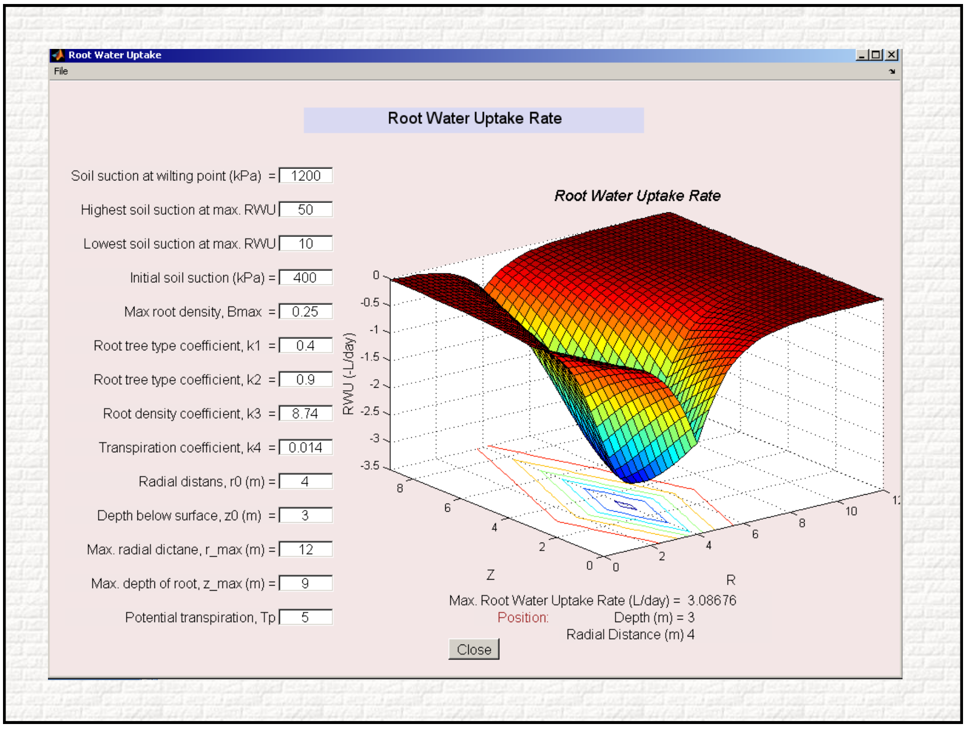
Time Step

Stage No.	11	12	13	14	15	16	17	18	19	20
1	26.64	26.26	25.87	25.5	26.02	29.84	29.44	29.04	28.63	28.24
2	25.25	24.87	24.48	24.11	24.9	28.71	28.33	27.93	27.53	27.14
3	24.45	24.06	23.66	23.28	24.49	28.5	28.1	27.69	27.28	26.88
4	0	0	0	0	21.65	29.68	29.25	28.8	28.35	27.9
5	21.08	20.72	20.35	19.99	19.33	22.76	22.42	22.05	21.68	21.31
6	18	17.65	17.19	16.85	16.28	19.56	19.25	18.91	18.54	18.19
7	13.87	13.57	13.27	12.98	12.09	15.16	14.92	14.62	14.31	14
8	9.01	8.79	8.57	8.36	7.85	9.9	9.75	9.53	9.3	9.07
9	5.47	5.33	5.21	5.08	4.76	5.96	6.01	5.92	5.79	5.65
10	4.67	4.61	4.54	4.48	4.32	4.9	4.79	4.71	4.65	4.59
11	2.63	2.6	2.57	2.55	2.46	2.69	2.64	2.61	2.59	2.56
12	1.44	1.43	1.42	1.42	1.37	1.44	1.42	1.41	1.41	1.4

Back


Design and Construction of Roads on Expansive Subgrades
File
Design and Construction of Roads on Expansive Subgrade
Evaluation of the expansive nature of the subgrade
Help
Design and Construction Recommendations
Help
Close


Design and Construction of Roads on Expansive Subgrades
File
Design and Construction Recommendations for Expansive Subgrade
Input
Recommendations
CBR (%)
(Californian Bearing Ratio)
2
Overlay Thickness (CBR) = 642.72 mm
Swell (%)
3
Overlay Thickness (CD) = 298.99 mm
ESA
(Equivalent Standard Axles)
1.87e+07
Replacement Depth = minimum replacement depth 300mm
Characteristic Deflection
(mm)
1.8
Lime Stabilisation is Suitable
PI (%)
(Plasticity Index)
15
Geofabric Requirement is Strength Class C
Working Platform/Capping Layer Requirements =
% Passing 0.425mm Sieve
14
Working Platform and Capping Layer Needed
D85 (%)
85% of soil is less than this diameter
32.5
Main Menu
Close
Run



Root Water Uptake
File
Root Water Uptake Rate
Soil suction at wilting point (kPa) = 1200
Highest soil suction at max. RWU 50
Lowest soil suction at max. RWU 10
Initial soil suction (kPa) = 400
Max root density, Bmax = 0.25
Root tree type coefficient, k1 = 0.4
Root tree type coefficient, k2 = 0.9
Root density coefficient, k3 = 8.74
Transpiration coefficient, k4 = 0.014
Radial distans, r0 (m) = 4
Depth below surface, z0 (m) = 3
Max. radial dictane, r_max (m) = 12
Max. depth of root, z_max (m) = 9
Potential transpiration, Tp 5
Root Water Uptake Rate
RWU (-L/day)
Z
R
Max. Root Water Uptake Rate (L/day) = 3.08676
Position:
Depth (m) = 3
Radial Distance (m) 4
Close