midas GTS
Advanced Webinar

- Date: June 5, 2012
- Topic: General Use of midas GTS (Part II)
- Presenter: Vipul Kumar
Contents:

1. Recap
2. Boundary Conditions
3. Load Conditions
4. Analysis
5. Post-processing Results
6. Application Areas
Recap

Project details

• Fill material in the top layer, sand in the middle and loam at the bottom.
• Sheet pile embedded in the soil. (since 2-D analysis, modelled as a beam element).
• Non-linear material model (MC) to define the soil properties.
• Modeling anchors using truss element.
• Prestressed anchors embedded in the soil.
Recap

Size control

Meshing

Low order triangular elements are generated through loop mesher with an element size of 1.
Interface elements

How to create the interaction between the sheet pile and the neighboring soil

Rigid links need to be created for nodes that have been splitted above.
Boundary conditions

How to apply the different boundary conditions required for the project?
Boundary Conditions

- Support
- Ground supports
- Nodal Head/Flux
- Seepage Face/Flux
- Nodal Flux, Surface Flux
- Seepage Boundary Function
- Draining condition
- Slip surface
- Change element attribute

All boundary conditions can be applied both to FE and geometry.
Supports

Model > Boundary > Supports...
Ground Supports

Model > Boundary > Ground Supports...
Head & Flux

Model > Boundary > Nodal Head...
Model > Boundary > Nodal Flux...

Nodal Head Boundary
- BC Set: nodal head_right
- Object: Node
- 21 Node(s) Selected
- Feature Angle: 15 [Deg]
- Nodal Head: Value: 20 m
- Type: Total
- Direction: Global Y

Nodal Flux Boundary
- BC Set: nodal flux
- Object: Node
- 25 Node(s) Selected
- Feature Angle: 15 [Deg]
- Nodal Flux: Value: 5 m³/sec
- Direction: Global Y
Seepage Face & Flux

Model > Boundary > Seepage Face...
Model > Boundary > Seepage Flux...

Seepage Face

- BC Set: seepage face
- Type: Seepage Edge
- Object: Free Edge Element
- Mode: Add/Replace
- Total Head: 0 m

Seepage Flux

- Set: seepage flux
- Type: Edge Flux
- Object: Free Edge Element
- Mode: Add/Replace
- Surface Flux: 1 m³/sec/m
Seepage Boundary function

Assigns Boundary conditions in terms of time. Change of boundary conditions w.r.t time can be assigned in transient state analysis.
Example:
- Variation of water level of reservoir.
- Seasonal inflow and outflow of rain.
- Change of pumping rate of pump.
Drainage condition & Non-consolidation condition

Draining condition

Model > Boundary > Draining condition...

Applied in areas where excess pore pressure is zero.
Mainly applied to consolidation analysis and groundwater seepage analysis.

Non – consolidation condition

Model > Boundary > Non-consolidation condition...

...
Slip surfaces

Slip surface

Model > Boundary > Slip surface(Circular/Polygon)
Hardening of soil or other change in attributes can be accounted
How to apply the Loads?
Load conditions

- **Load**
  - Self Weight
  - Force, Moment
  - Prescribed Displacement
  - Pressure
  - Line / Element Beam Load
  - Nodal / Element Temperature, Temperature Gradient
  - Prestress
  - Nodal Mass
  - **Response Spectrum Analysis Data** (including **Various Design Spectrum Data**)
  - **Time History Analysis Data**
    - Time Forcing Function (including **54 Earthquake Acceleration Records**)
    - Ground Acceleration
    - Time Varying Static Load
    - Dynamic Nodal Load, Dynamic Surface Load
    - Time History Result Function

All loads can be applied both to FE and geometry.
Self weight

Independent load condition based on the body force.
Nodal /moment loads

Nodal Force

Model > Loads > Nodal force...

Moment

Model > Loads > Moment...

![Image of Nodal Force dialog box]

![Image of Moment dialog box]
Prescribed displacements

Prescribed Displacements

Examine the structural behaviors under the conditions where displacements for the restrained DOF are known.
• A rigid body motion is expected.
• Detailed safety diagnosis is needed in terms of ground deformation.
• When the displacements of specific part are used as the boundary conditions after the analysis of global model is performed.
Pressure load

Model > Loads > Pressure load...

Pressure Load

- Load Set: Pressure Load
- Type: Edge Pressure
- Object Type: Element Edge
- Free Face/Edge: Select Element(s)
- Seed Node: 15 [Deg]
- Feature Angle: 15 [Deg]
- Mode: Add
- Direction: Normal
- Ref. CSys: Global Rectangular
- Projection: Yes
- Uniform Pressure: P = 10
- Load Unit (P or P1): kW/m
Line/element beam load

**Line Load**

Model > Loads > Line load…

When a series of beams are connected continuously, just selecting both ends of the row of beam elements.

**Element beam Load**

Model > Loads > Element beam load…

When a series of connected continuous elements.
Temperature load

Temperature Load

Model > Loads > Nodal Temperature/Element Temperature/Temperature Gradient...

• Applying an element beam load is similar to applying a nodal temperature load at the nodes connecting the elements selected.
• Temperature gradient load is only considered for beam and plate elements.
Prestress

Model > Loads > Prestress...
Time history Load

Model > Loads > Time history Data...

Time History Load Set...
Time Forcing Functions...
Ground Acceleration...
Time Varying Static Loads...
Dynamic Nodal Loads...
Dynamic Surface Loads...
Time History Result Functions...

Generate Earthquake Acceleration Record

Earthquake
1940, El Centro Site, 270 Deg
1942, El Centro Site, 270 Deg
1940, El Centro Site, 180 Deg
1940, El Centro Site, Vertical
1952, Taft Lincoln School, 62 Deg
1952, Taft Lincoln School, 338 Deg
1952, Taft Lincoln School, Vertical
1952, Hollywood Storage P.E., 270 Deg
1952, Hollywood Storage P.E., 0 Deg
1952, Hollywood Storage P.E., Vertical
1971, San Fernando, 59 Deg
1971, San Fernando, 156 Deg
1971, San Fernando, Down
1979, James R.D. El Centro, 220 Deg
1979, James R.D. El Centro, 310 Deg
1979, James R.D. El Centro, Up
1979, Bonds Corner El Centro, 320 Deg
1979, Bonds Corner El Centro, 310 Deg
1979, Bonds Corner El Centro, Up
1985, Mexico City, Station 1, 182 Deg
1985, Mexico City, Station 1, 270 Deg
1994, Northridge, Sylmar County Hosp., 38 Deg
1994, Northridge, Sylmar, City Hall Grounds, 0 Deg
1994, Northridge, Santa Monica, City Hall Grounds, 30 Deg
1994, Northridge, Arleta and Northridge Fire Station, 90
1999, Loma Prieta, Oakland Outer Wharf, 270 Deg
1999, Loma Prieta, Oakland Outer Wharf, 0 Deg
1997, San Fernando Pico Rd, 126 Deg
1997, San Fernando, Pico Rd, 386 Deg
1996, Parkfield Cholame, 40 Deg
1996, Parkfield Cholame, 130 Deg
1997, San Fernando 824 Orton Blvd., 90 Deg
1997, San Fernando 824 Orton Blvd., 180 Deg
Method of Static Intensity - level - Type I
Method of Static Intensity - level - Type II
Method of Static Intensity - level - Type III
T1-I(1970), M10A-Cent, LS
T1-I(1978), M10AG-Centi, LS
T1-I(1973), MOK5150-IW-COAST, LS
T1-II(1988), M0G5150-IW-COAST, LS
T1-II(1988), M0G5160-IW-COAST, MR

Time History Load Function

Time Function Data Type
- Normalized Accel.
- Acceleration
- Force

Import
Earthquake

Time (sec) Function
1 0.020 -0.079
2 0.040 0.031
3 0.080 -0.041
4 0.000 -0.001
5 0.100 -0.053
6 0.120 0.003
7 0.140 0.093
8 0.160 -0.093
9 0.180 -0.049
10 0.200 -0.095
11 0.220 -0.094
12 0.240 0.030
13 0.260 0.087
14 0.280 0.087
15 0.300 0.062

Description: 1942, Taft Lincoln School, 338 Deg

Add/Modify Time History Load Set

General
- Load Set Name: MF
- Description:

Analytic Type
- Linear
- Modal
- Direct Integration

Time History Type
- Transient

End Time: 2 sec
Time Increment: 0.01 sec
Step Number Increment For Output: 1

Damping
- Direct Model
- Mass & Stiffness Proportional

Mass and Stiffness Coefficients
- Mass Proportional
- Stiffness Proportional

Damping Type
- Direct Specification
- Calculate from Model Damping

Coefficients Calculation
- Frequency [Hz]
  - 0.95
- Period [sec]
  - 0.88
- Damping Ratio
  - 0.05

Show Damping Ratio

Convergence Criteria
- Displacement Norm: 0.001
- Force Norm: 0.001
- Energy Norm: 0.001

Maximum Iteration: 10

OK Cancel Apply
Response Spectrum Load

Model > Loads > Response Spectrum Load...

Add/Modify/Show Response Spectrum Functions

Generate Design Spectrum

Design Spectrum

Site Class

Mapped Spectral Acceleration at

Maximum Period: 10 (Sec)

Operations

Add  Modify  Delete

OK  Cancel

Generate Design Spectrum

Design Spectrum

Site Class

Mapped Spectral Acceleration at

Maximum Period: 10 (Sec)

Operations

Add  Modify  Delete

OK  Cancel
Load Combination

Load Set

Model > Load > Load Set...
INDEX

Analysis Control

GTS  Analysis Case

Analysis Case

Construction Stage
Analysis Capabilities
Analysis Case

Analysis > Analysis Case...

Analysis Case

Analysis Type

Drag & Drop

Tree Structure

Excavation

Initial & Embanking

Solve Each Load Set Independently

Analysis Case

Analysis Type

Excavation

Slope stability

Seepage

Linear Static

Nonlinear Static

Construction Stage

Eigenvalue

Response Spectrum

Time History (Linear)

Seepage (Steady-State)

Seepage (Transient)

Consolidation

Slope Stability (SRM)

Slope Stability (SAM)
Parametric Study & Batch study

\[ K_0 = 0.5 \, @ \, 3.95\text{mm} \]

\[ K_0 = 1.0 \, @ \, 3.73\text{mm} \]

\[ K_0 = 1.5 \, @ \, 5.00\text{mm} \]

\[ K_0 = 2.0 \, @ \, 11.15\text{mm} \]
Post processing results
Post-processing

Works Tree

Contour Plot

Result Table

Result Graph

MS-Excel

<table>
<thead>
<tr>
<th>Node</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.004394</td>
<td>0.000727</td>
<td>-0.004332</td>
</tr>
<tr>
<td>2</td>
<td>0.004824</td>
<td>-0.002044</td>
<td>-0.004367</td>
</tr>
<tr>
<td>3</td>
<td>0.006663</td>
<td>-0.004990</td>
<td>-0.004402</td>
</tr>
<tr>
<td>4</td>
<td>0.003325</td>
<td>0.000801</td>
<td>-0.003286</td>
</tr>
<tr>
<td>5</td>
<td>0.003477</td>
<td>-0.001071</td>
<td>-0.003307</td>
</tr>
<tr>
<td>6</td>
<td>0.004475</td>
<td>-0.002650</td>
<td>-0.003352</td>
</tr>
<tr>
<td>7</td>
<td>0.002358</td>
<td>0.000509</td>
<td>-0.002299</td>
</tr>
<tr>
<td>8</td>
<td>0.002311</td>
<td>-0.000262</td>
<td>-0.002296</td>
</tr>
<tr>
<td>9</td>
<td>0.002561</td>
<td>-0.001090</td>
<td>-0.002311</td>
</tr>
<tr>
<td>10</td>
<td>0.000687</td>
<td>0.000349</td>
<td>-0.000564</td>
</tr>
<tr>
<td>11</td>
<td>0.007416</td>
<td>-0.002552</td>
<td>-0.006962</td>
</tr>
<tr>
<td>12</td>
<td>0.004645</td>
<td>0.000360</td>
<td>-0.004451</td>
</tr>
</tbody>
</table>
Contour Plot Types

- Contour with Mesh
- Contour with Iso-line
- Contour with Mesh & Iso-line
- Contour without Mesh
- Gradient Contour
- Gray Contour
Contour with Deformation

Front View

Side View

Displacement Contour (Gradient Plot) with Deformed Shape

Undeformed Model
Iso-surface Plots

Multiple Iso-surfaces with Feature-Edge

Multiple Iso-surfaces with Mesh
Iso-surface Plots (Capped)

Original Iso-surface Plot (Multiple Plots)

Base Iso-surface

Capped Plot (Lower Part)

Capped Plot (Upper Part)

Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iso Surface</td>
<td>10.040000</td>
</tr>
<tr>
<td>Cutting Part</td>
<td>Both Part</td>
</tr>
<tr>
<td>Preview</td>
<td>True</td>
</tr>
<tr>
<td>Sensitive</td>
<td>False</td>
</tr>
<tr>
<td>Iso Value</td>
<td></td>
</tr>
<tr>
<td>Value 1</td>
<td>11.300000</td>
</tr>
<tr>
<td>Value 2</td>
<td>13.680000</td>
</tr>
<tr>
<td>Value 3</td>
<td>15.800000</td>
</tr>
<tr>
<td>Value 4</td>
<td>17.500000</td>
</tr>
<tr>
<td>Value 5</td>
<td>19.290000</td>
</tr>
<tr>
<td>Value 6</td>
<td>20.320000</td>
</tr>
<tr>
<td>Value 7</td>
<td>21.400000</td>
</tr>
</tbody>
</table>
Slice Plots

Multiple Slice Planes (Solid)
Clipping Plots

Original Plot

Curved Tunnel (Slice Plot)

Clipped Plot (Upper Part)

Clipped Plot (Lower Part)

Clipping Plane Definition by Mouse Dragging
Partition Plots

Model
(6 Mesh Sets)

Original Plot

Partitioned Plot

Mesh Set based Partition

Detach mesh sets by mouse dragging

Front View

Side View
Hybrid Plots

- Front View
- Vector Plot
- Contour Plot
- Original Plot
- Top View
- Clipped Contour Plot + Vector Plot
Diagram Plots

Axial Force of 2D Embedded Trusses (R/B)

Axial Force of 3D Embedded Trusses (R/B)

Beam Force Diagram (2D Shotcrete)

Beam Moment Diagram (2D Shotcrete)
Vector Plots

Vector Plot without Mesh

Vector Plot on Contour (Principal Strain)
Animations

2D Construction Stage Analysis

3D Construction Stage Analysis
(Clipped Plot)
Result Extraction

3D Step Graph

Location

Stage

Result
Settlement Profiles

Mesh & Displacement Contour

Define Settlement Grids

Settlement Profile (3D Plane, 2D Line)

Settlement (MS-Excel Compatible Table)
On-Curve Diagrams

3D On-Curve Graphs on Contour Plot

Result Data at User-Specified Sampling Points

2D On-Curve Graphs on Contour Plot
## Probe & Result Tag

### Probe Result

<table>
<thead>
<tr>
<th>Show</th>
<th>Type</th>
<th>ID</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑</td>
<td>Node</td>
<td>6733</td>
<td>-0.0000</td>
<td>50.0000</td>
<td>64.0000</td>
<td>Max: 0.00149682</td>
</tr>
<tr>
<td>☑</td>
<td>Node</td>
<td>3332</td>
<td>-1.0180</td>
<td>5.0714</td>
<td>72.7347</td>
<td>Min: -0.00135158</td>
</tr>
</tbody>
</table>

- **Update**: Update the probe result
- **Clear All**: Clear all probe results
- **Restore Value**: Restore the default value
- **Max**: Show the maximum value
- **Min**: Show the minimum value

### Side View

- Max: 0.00149682
- Min: -0.00135158
Probe & Result Tag
Application Areas

- Deep Foundations and Soil-Structure Interaction
  - Piled-raft Foundation for high-rise buildings (taller than 50-story)

- Deep Excavation and Temporary Structures
  - New building foundation neighboring 3 arch tunnels
  - Temporary structures

- Unconventional Tunnel Intersections
  - 3D Modeling of unconventional tunnel interconnections
  - Stress contours

- Shield TBM Analysis considering excavation sequences
  - Construction field - Shield TBM
  - Displacements contours
Application Areas

- **Vibration analysis for Earthquake & Blasting**

  Dynamic effects of high speed train

- **Groundwater Flow and Coupled Analyses**

  Stress-seepage semi-coupled analysis of 3D slope
  CFRD (Concrete Faced Rockfill Dam)

- **Underground Structures**
  (subway, disposal facilities & etc.)

  Project Rendering
  3D modeling of Subway Station

- **Slope Stability and Embankments**

  SRM (Strength Reduction Method)
  SAM (Stress Analysis Method)
Thank You!

For more information, please visit us at [http://en.midasuser.com](http://en.midasuser.com)