midas GTS
Advanced Webinar

Topic: Construction Stage Analysis

Vipul Kumar,
Geotechnical Engineer

August 21, 2012
1. Introduction to CSA
2. Wizards for CSA
3. Analysis types in CSA
4. Analysis Options
5. Application Areas
6. Special Post Processing features for results of CSA
# Index

<table>
<thead>
<tr>
<th>1. Introduction to CSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Wizards for CSA</td>
</tr>
<tr>
<td>3. Analysis types in CSA</td>
</tr>
<tr>
<td>4. Analysis Options</td>
</tr>
<tr>
<td>5. Application Areas</td>
</tr>
<tr>
<td>6. Special Post Processing features for results of CSA</td>
</tr>
</tbody>
</table>
Introduction to CSA

1. In real life problems construction commences on ground having some initial stress.
2. Thus for accurate real life simulation of construction phase, necessary to create an in-situ stress conditions before hand.
3. Process of construction spread into number of days representing different stages.
4. During construction –
   i. Soil may be excavated – (e.g. foundations, tunnel)
   ii. Changes may take place in material properties of soil (Compaction / Replacement)
   iii. Structural loads may be imposed or removed from soil.
   iv. Changes in ground water flow due to dewatering
   v. Settlement / Consolidation may occur during staged excavation.
5. These changes not reflected when performing simple Non-linear static analysis.
6. Construction Stage Analysis – Solution for modeling the situations mentioned above.
## INDEX

1. Introduction to CSA

2. Wizards for CSA

3. Analysis types in CSA

4. Analysis Options

5. Application Areas

6. Special Post Processing features for results of CSA
midas GTS provides two wizards for simulating construction stages.
Define Construction Stage Wizard

1. Most commonly used for defining different stages of construction.
2. Useful when number of stages are few.

- Various analysis types
- All mesh sets, load and boundary conditions displayed in a tree structure
- Load Step allows the user to have more control on load stepping for a particular stage
- Different convergence criteria and number of iterations can be applied to each stage for better convergence.

Check on to assess the Stability. SAM is only for 2D and requires BC. SRM is for 2D and 3D.

Saves stage results in case analysis fails.
Define Construction Stage Wizard

1. Most commonly used for creating different stages of construction.
2. Useful when number of stages are few.
2. Useful when number of stages are many.

2. Useful when number of stages are many.

Postfix ???

Used for arranging multiple mesh sets in a particular order usually that of excavation / construction

1. Single Mesh sets/loads and Boundary Conditions represented by a dash.
2. Need to be directly dragged and dropped into Element, Boundary, Load Set Activation Status
1. When a number of solids are meshed together (e.g. 10) the created mesh sets are not in order.
2. Sorting these mesh sets in the order of construction is very important.
3. Sorting done by using “Mesh Rename” function.
4. Mesh > Mesh Set > Rename…

Mesh sets sorted along Global Y-Axis
1. Any change in material property (Hardening of Shotcrete) can be represented by “Change Element Attribute” Boundary Condition.

2. **Model > Boundary > Change Element Attribute…**

3. **Model > Boundary > Change Element Attribute for CS…**

This function automatically assigns the boundary condition of the elements and organizes their Boundary Sets using a naming convention.

**Useful for changing the Attribute of single mesh set**
Summary of CS Wizards

With the wizards available, for each construction stage it is possible to

1. Specify the type of Construction Stage.
2. Activate/ Deactivate mesh sets/ loads/ B.C.
3. Initialize displacements to zero.
4. Specify the load stepping procedure (only for “Construction” stage type).
5. Specify the iteration scheme and number of iterations for better convergence.
6. Specify the LDF for sequential stress transfer (only for “Construction” stage type).
7. Specify water level for the entire model or a single mesh set as a value or as a function.
8. Perform drained/undrained analysis.
9. View activated/deactivated elements and thus simulate the construction process by selecting filter of showing elements as “Activated” and browsing through each step.
11. Save for restart in case of failed analysis.
12. Assess the stability during that particular stage.
# INDEX

1. Introduction to CSA

2. Wizards for CSA

3. **Analysis types in CSA**

4. Analysis Options

5. Application Areas

6. Special Post Processing features for results of CSA
Analysis Types in CSA

1. Construction – (Static Non Linear Analysis)
   a. Drained
   b. Undrained

2. Seepage – Steady State & Transient

3. Consolidation

4. Semi Coupled (Stress + Seepage)

Note: For Consolidation Analysis all stages must be “Consolidation” only.

Not possible to couple with any other Stage Type.
Analysis Types in CSA

1. Using “Define Construction Stage Wizard”, possible to define the type of Construction Stage.

2. For Undrained Analysis – Check on Undrained in Construction Stage and define material parameters as Undrained.
1. For “Consolidation” and “Seepage Transient” necessary to define the time steps.
1. For “Consolidation” and “Seepage Transient” necessary to define the time steps
Analysis Types in CSA

1. Semi Coupled Analysis
2. First Stage is “Seepage” next is “Construction”.
3. Solver calculates pore pressure in Seepage Analysis and carries it forward into Stress Analysis.
4. Results of Seepage Analysis and Stress Analysis are displayed separately.
INDEX

1. Introduction to CSA

2. Wizards for CSA

3. Analysis types in CSA

4. Analysis Options

5. Application Areas

6. Special Post Processing features for results of CSA
1. Possible to save results up to a particular stage.
2. Stress initialization option available in Analysis control. – Specify stage for same.
3. Necessary to define unit weight, self weight factor (and $K_0$ for $K_0$ condition).
4. $K_0$ condition – Strictly applicable for horizontal layers, for sloping ground check-off $K_0$.
5. Restart Option - Specify the restarting option when the analysis is terminated during the analysis.
1. Four different iteration schemes – Default is NR in CSA.

2. Three types of Convergence Criteria – Default is Force Norm with a value 0.001. Smaller the value of norm more the accuracy but chances of analysis not converging because of it also increases.

3. Load Stepping procedures
   a. Manual – Load is divided into number of defined steps and then applied. Used for most of the cases. Used for cases where highly non-behavior is not expected.
   b. User defined – User can control the increment size of the load. Load Factor can be –ve and greater than 1 since input on load factor is not limited.
   c. Automatic loading – Loading done automatically
   d. Arc length method – Useful in case of large loads for accurate prediction of collapse loads.

4. Option to save either only the last step or all steps in an analysis.
INDEX

1. Introduction to CSA
2. Wizards for CSA
3. Analysis types in CSA
4. Analysis Options
5. Application Areas
6. Special Post Processing features for results of CSA
Application Areas

1. **Tunnel Construction** – Realistic simulation of tunnel excavation followed by Shotcrete application and its hardening as well as Rockbolt installation can be considered.

2. **Deep excavation** – Possible to simulate the process of dewatering followed by excavation and capture the resulting change in stress by performing a semi-coupled analysis.

3. **Staged Embankment Construction** - where the effects of consolidation and undrained loading need to be observed may be easily considered in GTS.

4. **Slope Stability Assessment using RFOC for Construction stages** – Stability check during different Construction stages may be performed by activating the respective switch in the stage

Note: Above cases are simple examples where CSA is performed and does not in any way limit the use of CSA to these problems only.
INDEX

1. Introduction to CSA
2. Wizards for CSA
3. Analysis types in CSA
4. Analysis Options
5. Application Areas
6. Special Post Processing features for results of CSA
1. **Extract Result function** – Useful for extracting a particular result at some point in the model for either all or some of the construction stages.

2. **Use of Sensitive Button for scrolling through different Construction Stages** – The result for each stage can be checked by using this feature and simply scrolling through the stages.

3. **Animation** – The changes in result during either a particular stage or all stages can be captured in a video format using the animation feature of midas GTS.

4. **Multi-step iso surface** - Useful in case of seepage analysis to view the phreatic surface during different stages of construction.
THANKS

For Queries:- email to esupport@midasit.com