Advanced FEMAP Programming with Applications to Structural Analysis

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Typical Analysis Process

Six “Easy” Steps

1. Design Structure
   - Design Tools
     - Pro/Engineer
     - CATIA
     - AutoCAD
     - etc.

2. Mesh Geometry

3. Run Analysis
   - Solvers
     - NASTRAN
     - ABAQUS
     - ANSYS
     - etc.

4. Observe Performance
   - Post-Processors
     - FEMAP
     - Notepad
     - PATRAN
     - etc.

5. Compute Margins
   - Pre-Processors
     - FEMAP
     - PATRAN
     - Algor
     - etc.

6. Document Results
   - Word Processors
     - WORD
     - Anything else
     - etc.

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FEMCI Workshop 2002
Simplified Analysis Process

Now only FOUR steps

Use FEMAP to Control External Software

1. Design Structure
   - Design Tools
     - Pro/Engineer
     - CATIA
     - AutoCAD
     - etc.

2. Mesh Geometry

3. Run Analysis
   - Solvers
     - NASTRAN
     - ABAQUS
     - ANSYS
     - etc.

4. Observe Performance
   - Compute Margins
   - Document Results
   - Post-Processors
     - FEMAP
FEMAP’s Programming Capabilities

Old Versions of FEMAP
- Advanced Programming Interface (API)
  - Add more functionality to FEMAP
  - Interface with other VB driven programs
  - But **NOT** vice-versa

New to FEMAP v8.1
- Object Linking and Embedding (OLE)
  - Objects that define FEMAP processes
  - Two-way communication with OLE programs
Example 1: Organizing a FEMAP Model

- Use EXCEL to Control FEMAP
- Renumber Entities
  - Nodes, Elements, Properties, Materials, etc.
  - By layer, color, group, etc.
- Extract Model Information
  - Mass, Volume, CG, Layer/Group/Color Name, etc.

- Output Model Information
  - All Information Displayed in a Formatted Table
  - Can Be Easily Transferred to a Stress Report
Example 1: Organizing a FEMAP Model

FEA Model + feDocument, Build 1.11 BETA =

INSTRUCTIONS:
1. Load your FEMAP model file BEFORE executing this routine.
2. Verify that your model is in FEMAP v8.1 format.
3. Make sure that only ONE instance of FEMAP is running.
4. Make sure that your model file does NOT have any stored OUTPUT information.
5. Organize your model into discrete layers.
6. Specify the following parameters:
   - Renumber Model
   - Start ID
   - ID Increment
   - Renumber Properties
   - Renumber Materials
   - G Factor
   - Generate Groups
   - Save Model
7. Make sure that this is what YOU want to do - there is NO UNDO!

Questions? Send email to: wmcoll@swales.com

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### Example 1: Sample EXCEL Output

#### Table 1: Node, Element, Mass, and CG Information

<table>
<thead>
<tr>
<th>Description</th>
<th>Layer ID</th>
<th>Node Range</th>
<th>Element Range</th>
<th>Nodes</th>
<th>Elements</th>
<th>S Mass (pounds)</th>
<th>NSM (pounds)</th>
<th>Total Mass (pounds)</th>
<th>Volume (in³)</th>
<th>XCG (in)</th>
<th>YCG (in)</th>
<th>ZCG (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS Honeycomb Facesheet</td>
<td>1</td>
<td>3937</td>
<td>3707</td>
<td>3936</td>
<td>3706</td>
<td>4.23</td>
<td>0.22</td>
<td>4.44</td>
<td>43.08</td>
<td>-0.31</td>
<td>-9.52</td>
<td>-0.51</td>
</tr>
<tr>
<td>DS Honeycomb Core</td>
<td>2</td>
<td>7366</td>
<td>7916</td>
<td>3366</td>
<td>3916</td>
<td>2.23</td>
<td>0.00</td>
<td>2.23</td>
<td>884.22</td>
<td>-0.45</td>
<td>-9.53</td>
<td>-0.61</td>
</tr>
<tr>
<td>DS Stanchion Inserts</td>
<td>3</td>
<td>8669</td>
<td>10200</td>
<td>669</td>
<td>2200</td>
<td>2.40</td>
<td>0.00</td>
<td>2.40</td>
<td>24.51</td>
<td>0.76</td>
<td>-9.15</td>
<td>0.37</td>
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<tr>
<td>DS Brace Inserts</td>
<td>4</td>
<td>11304</td>
<td>11792</td>
<td>304</td>
<td>792</td>
<td>0.76</td>
<td>0.00</td>
<td>0.76</td>
<td>7.76</td>
<td>1.13</td>
<td>-9.38</td>
<td>0.22</td>
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<tr>
<td>DS Interface Inserts</td>
<td>5</td>
<td>12342</td>
<td>12432</td>
<td>504</td>
<td>432</td>
<td>1.63</td>
<td>0.00</td>
<td>1.63</td>
<td>16.60</td>
<td>-0.31</td>
<td>-9.53</td>
<td>-0.51</td>
</tr>
<tr>
<td>DS Potting Material</td>
<td>6</td>
<td>13904</td>
<td>0</td>
<td>904</td>
<td>1.22</td>
<td>0.00</td>
<td>0.00</td>
<td>1.22</td>
<td>52.68</td>
<td>-0.17</td>
<td>-9.53</td>
<td>-0.46</td>
</tr>
<tr>
<td>DS Stanchions</td>
<td>9</td>
<td>17761</td>
<td>17761</td>
<td>3761</td>
<td>3761</td>
<td>5.60</td>
<td>0.00</td>
<td>5.60</td>
<td>57.09</td>
<td>-2.65</td>
<td>-3.94</td>
<td>1.78</td>
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<td>DS Braces</td>
<td>10</td>
<td>20672</td>
<td>20762</td>
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<td>16.75</td>
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<tr>
<td>DS Fasteners</td>
<td>11</td>
<td>21063</td>
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<td>63</td>
<td>0.00</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<td>1548</td>
<td>2.22</td>
<td>0.14</td>
<td>2.36</td>
<td>18.59</td>
<td>-0.06</td>
<td>1.38</td>
<td>-0.20</td>
<td>3.56</td>
</tr>
</tbody>
</table>

#### Model File Information

- Renumbers Node, Elements
- Includes Layer Names
- Sorts by Layer ID
- Reports CG Information
- Provides Model Summary (# Nodes, Elements, Total Mass, etc.)
Post-Processing Tasks

- MS EXCEL
- MATLAB
- MathCAD
- TK Solver
- C++, VB, etc.

Analysis Tools

Solver (a.k.a. Black Box)

FEMAP Database

Graphics Package

Word Processing

- MS Word
- Word Perfect
- MS EXCEL
- etc.

Via OLE

Via OLE

Via OLE

Via OLE
The FEMAP Database

- Can store any form of information
  - This includes analysis results from external software
  - Results can be retrieved and formatted as a MS Word document
- Database can be manipulated by external software
  - So long as it is OLE compatible
  - Demonstrated in the previous example
Example 2: Fastener Analysis

 análize Fasteners for Tension Failure

Select Fastener Elements

Select Output Data to Process

Specify Fastener Parameters

(calculating)

Display Results in FEMAP

Save Results in Database
**Example 2: Screen Shots**

**Step 1: Select Fastener Elements**

900 pounds

UNC 10-32 Fasteners (x 4)
Example 2: Screen Shots (cont’d)

☞ Step 2: Select Output Set

☞ Step 3: Specify Fastener Options
Example 2: Crunch Numbers in EXCEL
Example 2: Display Analysis Output

Process Can Be Extended to Virtually any Analysis Task
'How Can I Do These Cool Things?

IF (you are a FEMAP User…) IS TRUE THEN

📍 Step 1: Upgrade to FEMAP v8.1
📍 Step 2: Play Around with Visual Basic for Applications
  ➣ Very, Very Simple Compared to C++, FORTRAN
📍 Step 3: Review the FEMAP Programmers Manual
  ➣ Copy from FEMAP Install CD or Download from EDS
📍 Step 4: Use the “Help” Files of OLE Compatible Software
  ➣ Here is where you can find examples on how to use the specific OLE interface objects for each program
📍 Step 5: Come up with Cool Ideas
  ➣ R.O.T.: There is ALWAYS something that needs to be simpler

ELSE
📍 Become a FEMAP User (LOOP)

END IF
Future Possibilities

- Buckling Analysis according to Bruhn
  - Algorithm to Identify a Representative Stress to Compare to Buckling Allowables
- Store Element Information within FEMAP Database
  - Examples
    - Fastener sizes represented by springs
    - Idealized BC information for QUADs that make up a panel
    - Recover This Information As Needed for Analysis
- Automated Documentation of Model with Screen Shots according to Layer or Group
- Expand Element, Property, and Material Database
  - Add Unsupported/Custom Element and Property Types
- Anything Else…