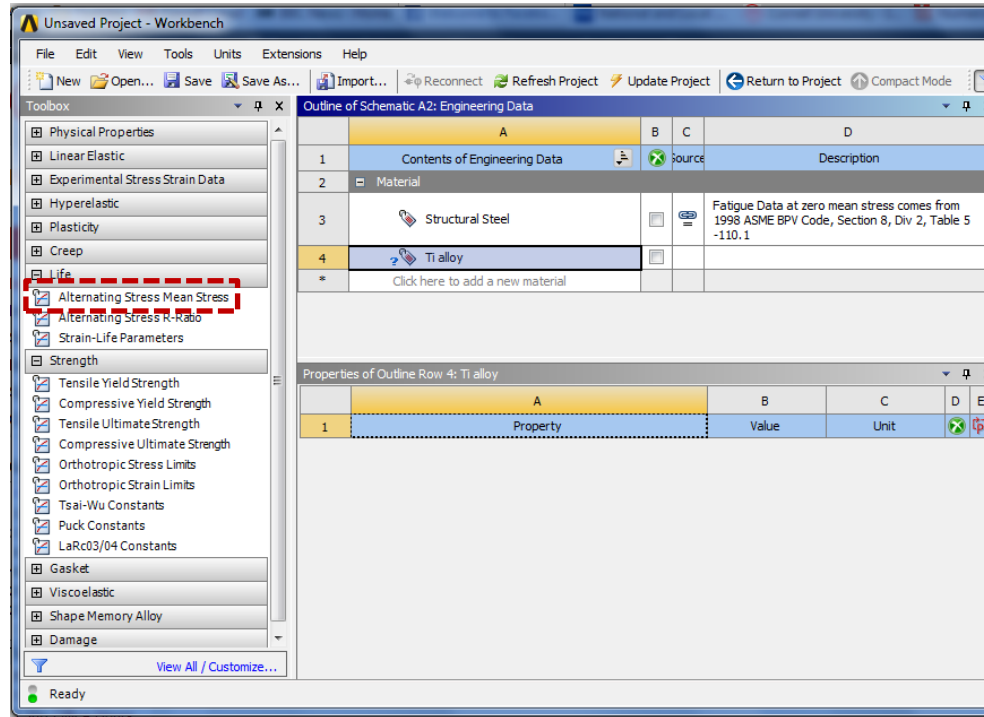


**MAE 3250**

**Fall 2013**

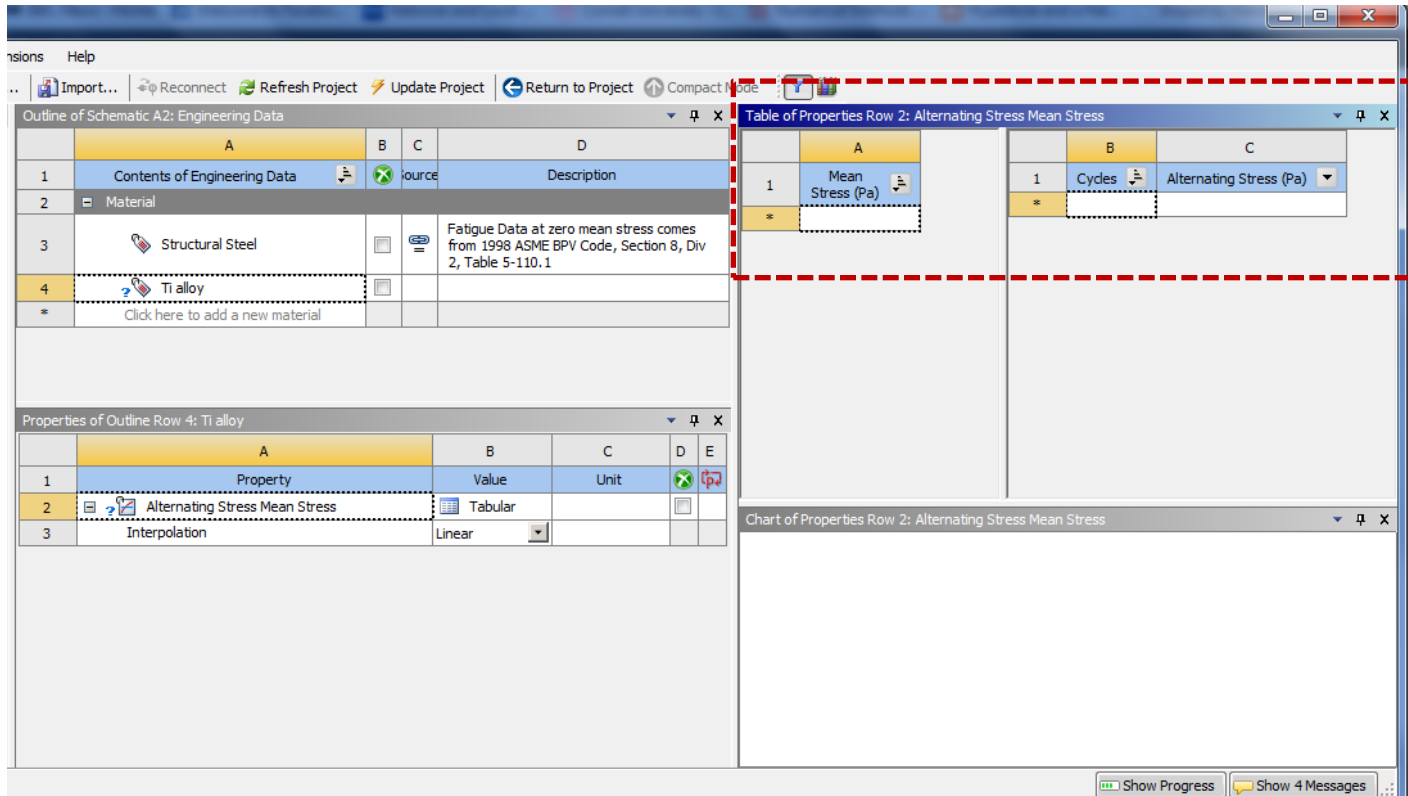
**Project 3 Fatigue Tutorial**

# Fatigue Properties in ANSYS



- Under **Life** category, import **Alternating Stress Mean Stress** by double clicking on it
- Expand it to display a table of properties and interpolation choices

# Fatigue Properties in ANSYS



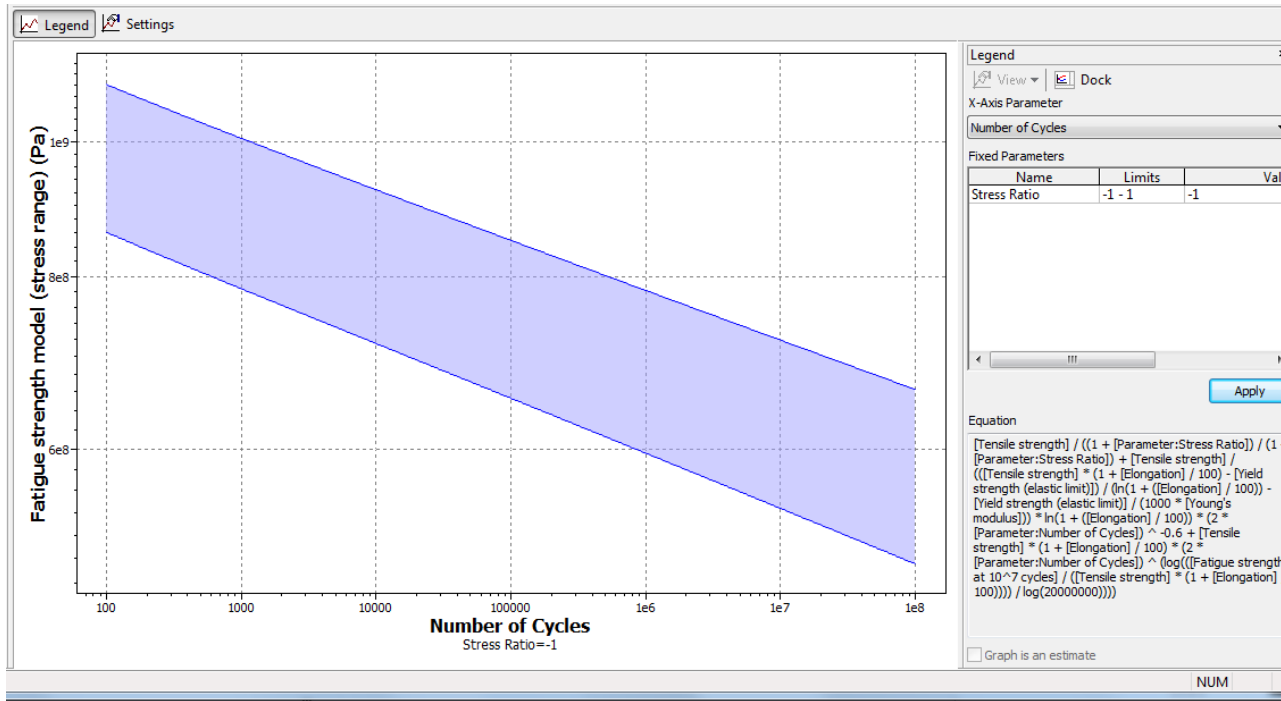
- Input the mean stress value and fatigue data necessary
- Use CES to determine values for number of cycles and alternating stress

# Fatigue Properties in CES

- Use CES to determine fatigue data required in ANSYS
  - number of cycles and stress amplitude (alternating stress)
- Make sure to understand what “stress range” refers to and how to obtain the stress amplitude from it
- Specify an R-ratio such that there is completely reversed loading

Layout: All attributes		Show/Hide	
Base		Ti (Titanium)	
<b>Composition detail (metals, ceramics and glasses)</b>			
Al (aluminum)	6		%
Ti (titanium)	90		%
V (vanadium)	4		%
<b>Mechanical properties</b>			
Young's modulus	16.1	- 17.3	10 <sup>6</sup> psi
Flexural modulus	* 16.1	- 17.3	10 <sup>6</sup> psi
Shear modulus	5.8	- 6.53	10 <sup>6</sup> psi
Bulk modulus	17.8	- 22.2	10 <sup>6</sup> psi
Poisson's ratio	0.35	- 0.37	
Shape factor	11		
Yield strength (elastic limit)	148	- 157	ksi
Tensile strength	160	- 184	ksi
Compressive strength	* 160	- 167	ksi
Flexural strength (modulus of rupture)	148	- 160	ksi
Elongation	8	- 13	% strain
Hardness - Vickers	380	- 420	HV
Hardness - Brinell	52.4	- 56	ksi
Fatigue strength at 10 <sup>7</sup> cycles	* 88.9	- 92.5	ksi
Fatigue strength model (stress range)	* 97.1	- 127	ksi
<a href="#">Parameters:</a> Stress Ratio = -1, Number of Cycles = 1e5			
Fracture toughness	74.6	- 91	ksi-in <sup>0.5</sup>
Mechanical loss coefficient (tan delta)	0.001	- 0.005	
<b>Thermal properties</b>			
Melting point	2.92e3	- 3.02e3	°F
Maximum service temperature	662	- 788	°F
Minimum service temperature	-459		°F
Thermal conductivity	4.4	- 4.22	BTU-ft/(hr-in <sup>2</sup> -°F)

# Fatigue Properties in CES



- Use CES to determine fatigue data required in ANSYS
  - number of cycles and stress amplitude (alternating stress)
- Make sure to understand what stress range refers to and how to obtain the stress amplitude from it
- Specify an R-ratio such that there is completely reversed loading

# Fatigue Properties in ANSYS

The screenshot displays the ANSYS interface for configuring fatigue properties. It includes three main panels:

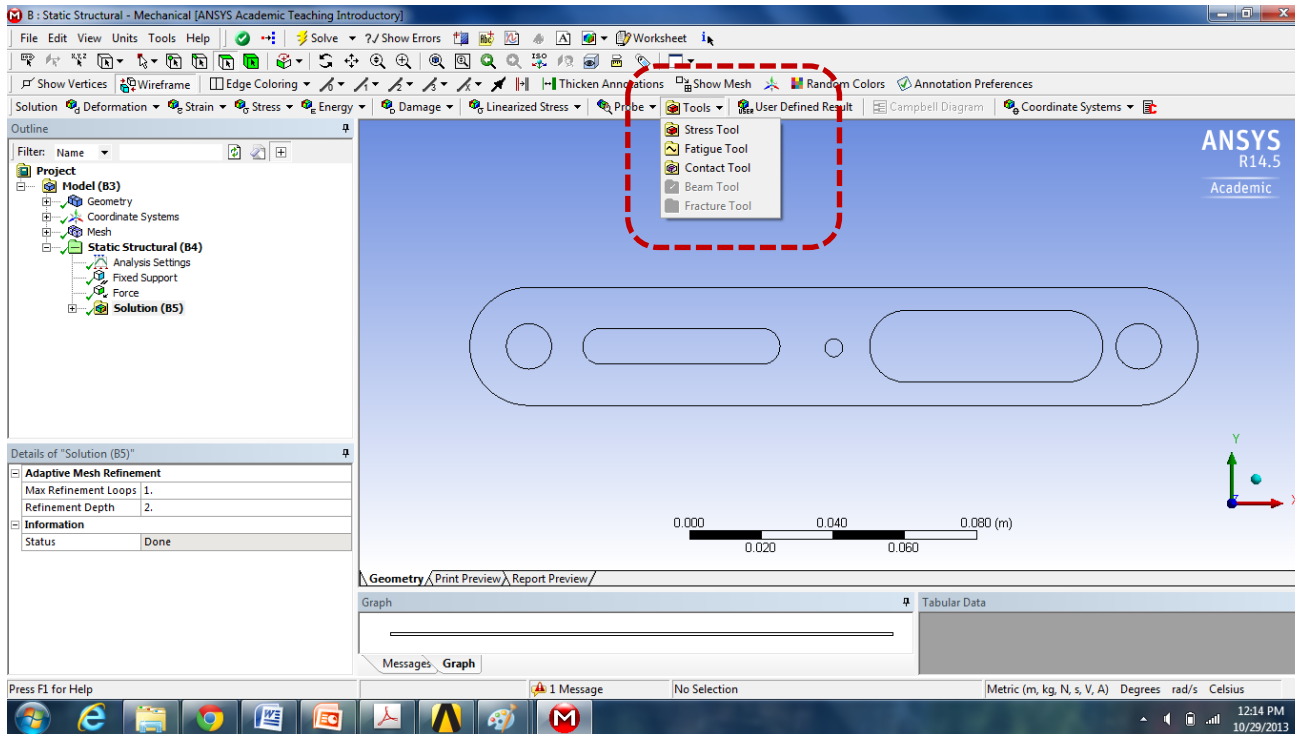
- Outline of Schematic B2: Engineering Data:** A table listing materials. Row 5, 'TiAlloy', is highlighted. A note indicates that fatigue data at zero mean stress is derived from the 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1.
- Properties of Outline Row 5: TiAlloy:** A table of material properties. Row 8, 'Alternating Stress Mean Stress', is highlighted with a red dashed box. The 'Interpolation' is set to 'Log-Log'.
- Table of Properties Row 8: Alternating Stress Mean Stress:** A table defining the relationship between Cycles and Alternating Stress (Pa). The data points are as follows:

Cycles	Alternating Stress (Pa)
10	1.5531E+09
100	1.3333E+09
1000	1.1445E+09
10000	9.8249E+08
1E+05	8.434E+08
1E+06	7.24E+08
1E+07	6.215E+08

Below the table is a **Chart of Properties Row 8: Alternating Stress Mean Stress**, which is a log-log plot of Alternating Stress (Log<sub>10</sub>) versus Cycles (Log<sub>10</sub>). The plot shows a downward-sloping red line with data points corresponding to the table above. The mean stress is indicated as 0 [Pa].

- Specify how your data is distributed (ie linear, semi-log, log-log). A good guess is the Log-Log scale.
- **Return to Project** and save your data

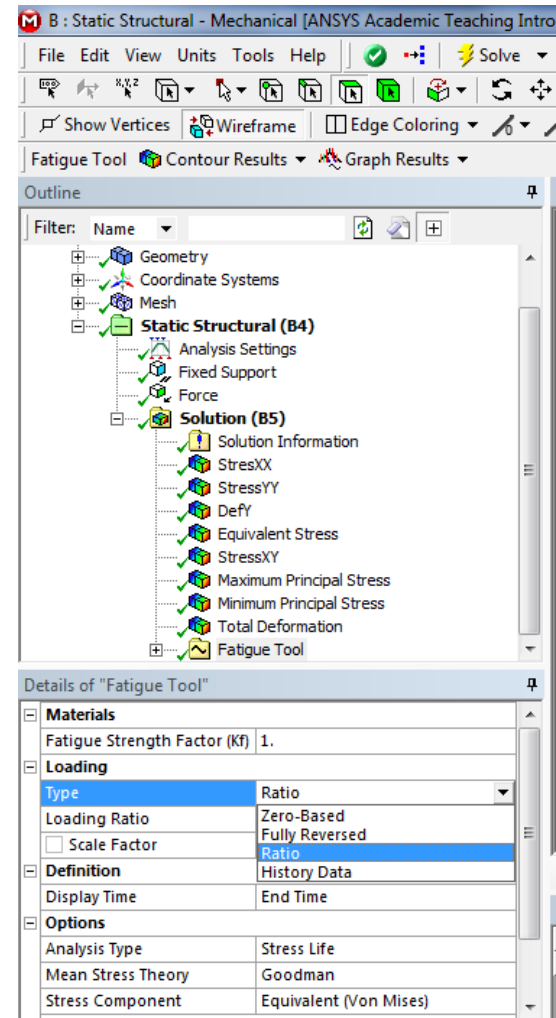
# Fatigue Tool in ANSYS



- Complete the static analysis before performing the fatigue analysis
- Once you have a solution to the static analysis, under **Tools**, select **Fatigue Tool**

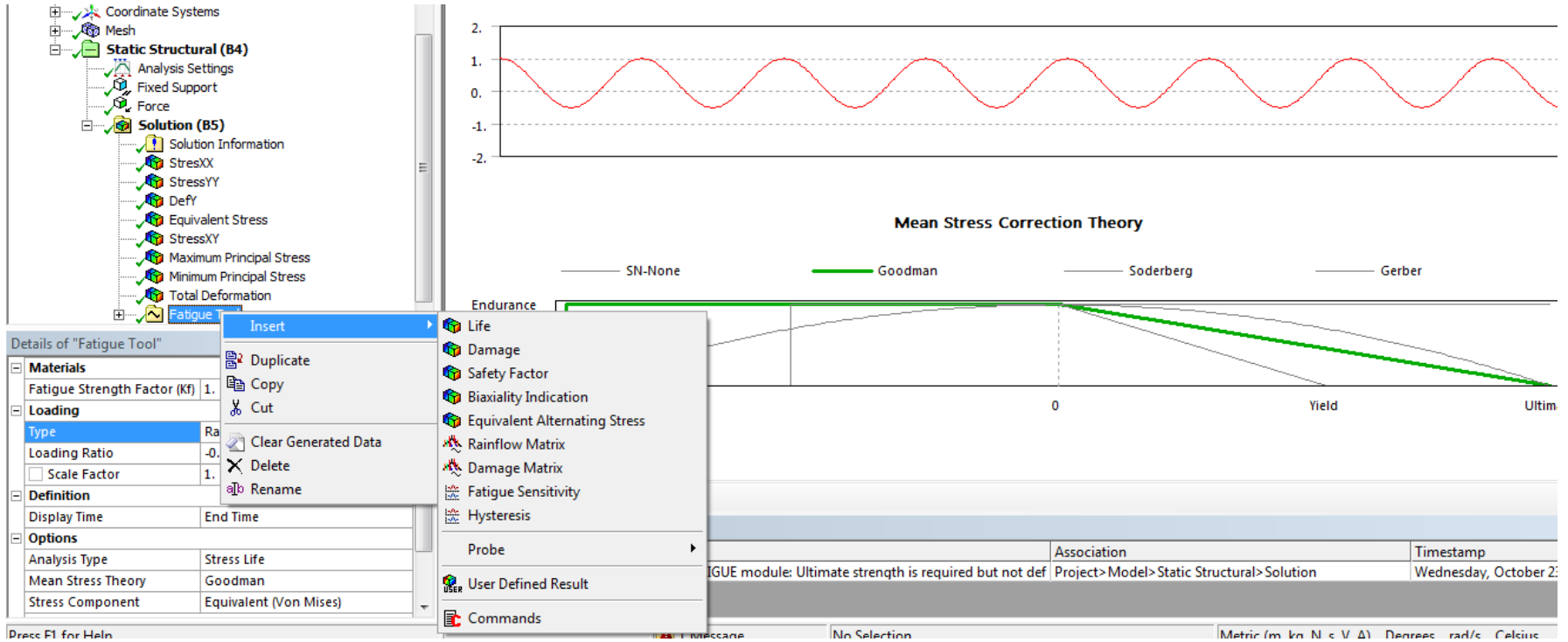
# Fatigue Tool in ANSYS

- Click on **Fatigue Tool**
- Under **Loading Type** in the details window, select **Ratio** and specify fatigue loading ratio
- Under **Mean Stress Theory** select **Goodman**
  - This will require having specified the ultimate tensile strength material property





# Fatigue Tool in ANSYS



- Right click on Fatigue tool, and insert desired values to solve
  - Safety factor (make sure to specify the desired number of cycles)
  - Equivalent alternating stress
  - These values will also give an indication of the most susceptible point of failure in fatigue

# Fatigue Tool in ANSYS

- Solve for the fatigue properties
  - Should give you an idea for the most susceptible point of failure in fatigue
- Another fatigue tutorial also available online
  - <https://confluence.cornell.edu/display/SIMULATION/ANSYS+-+Fatigue+Analysis>