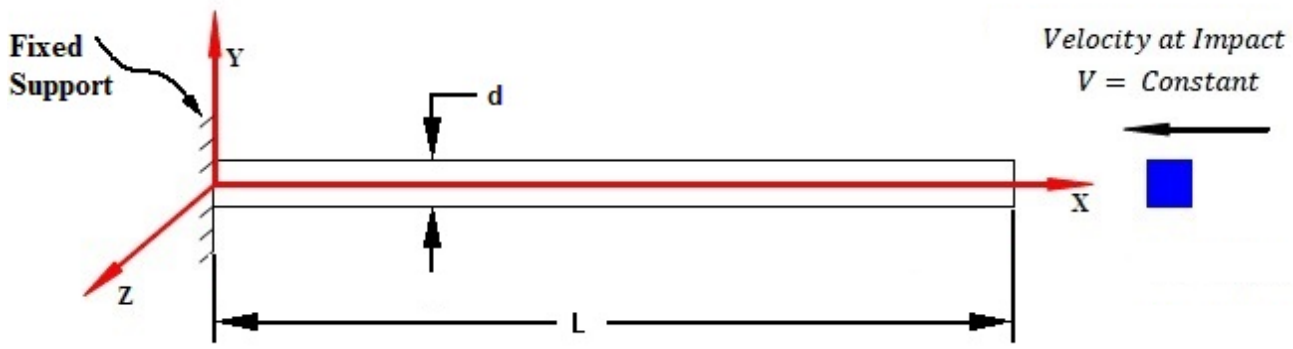
Transient Dynamic Impact Solutions – Episode II: Mass Impacting Rod

Run Notes & Keystroke Summary:
Transient Dynamic Impact Solutions – Episode II: Mass Striking Beam

9 October 2014



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1.0 Introduction

The input data files for the FEA model outlined in this document may be downloaded by contacting ***Applied Analysis & Technology*** at AppliedAT@aol.com.

The input data files and keystroke summaries are for use with **FeMap v11.1.2** and ***Patran 2013r1*** or later.

User notes for ***Patran*** are contained in ***Appendix A***. ***Patran*** users may download "***Rod_Impact_v2013.db***".

2.0 Getting Started

"***Rod_Impact_v11.1.2.modfem***" contains the complete solution files for transient response due to a concentrated mass, traveling at constant velocity, impacting the free end of a rod.

Getting Started

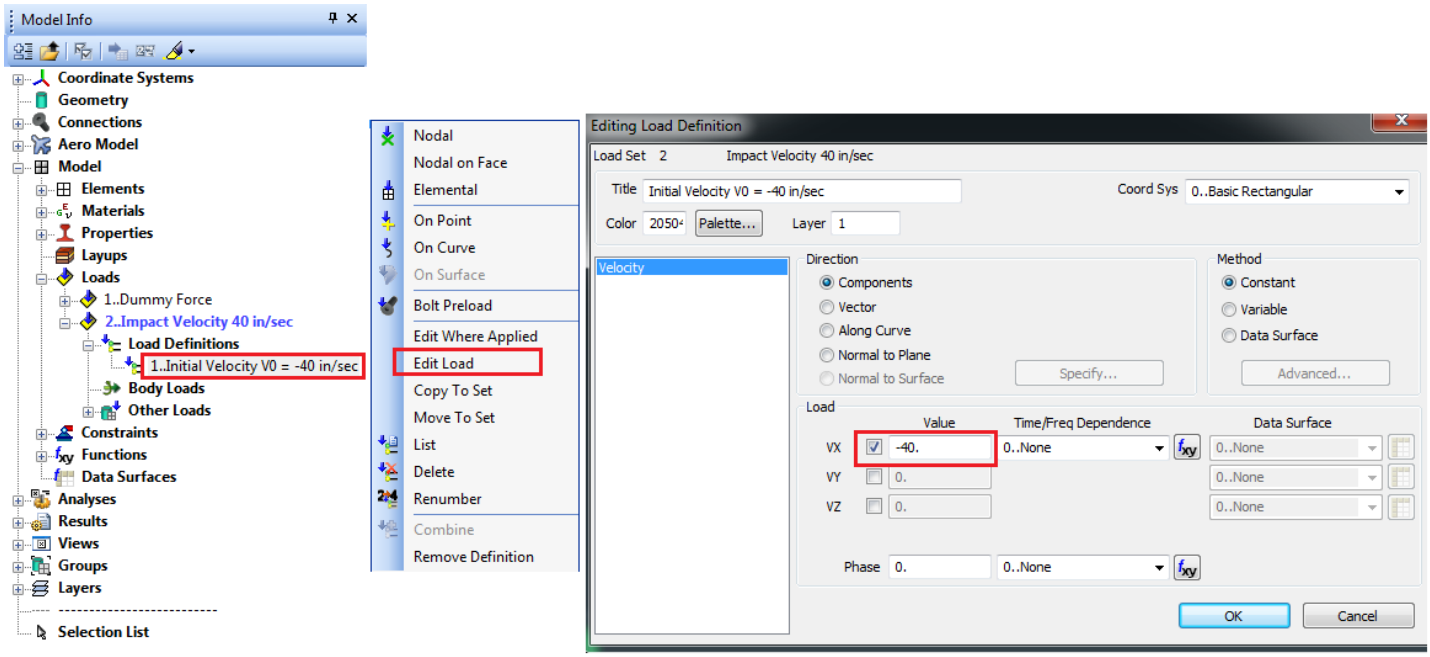
After first starting the program at the top menu bar: **File–Open** and locate the file "***Rod_Impact_v11.1.2.modfem***" from your download directory or the name that you have selected for your backup copy. Listed below are keystroke operations to lead one through this sample problem. One can either simply review the stored solution data and summary view screens or try re-processing some cases. The keystroke summaries are condensed operations to speed one through the sample problem.

Reviewing Input Parameters & Correct Units for Transient Dynamic Solution

- To check the bar material select **Modify–Edit–Material** **OK**. In the dialog boxes are data for "**Generic Steel**", note ***E = 30 x 10⁶ lbs/in²***, **ν = 0.3** and **ρ = 0.0007324 lbs-sec²/in⁴**. Select **Cancel** or **ESC** to exit.

- To check the bar section select **Modify–Edit–Property-Select All** **OK**. In the dialog boxes are data for "**1" Dia Steel Rod**", note ***A =0.7854 in²***. Data for "**50 lb Weight**", note ***Mx =0.1294 lb-sec²/in*** (50 lbs weight). Select **Cancel** or **ESC** to exit. One may also expand the **Model Info** and follow the steps shown below.

- To check the initial velocities, from the **Model Info** tree, Load Set **2.. Impact Velocity 40 in/sec**, right click on **1.. Initial Velocity V0= -40 in/sec**, right click on **Edit Load** note a value of ***VX = -40***. Select **Cancel** or **ESC** to exit. The **1.. Dummy Force** can be checked in a similar manor.



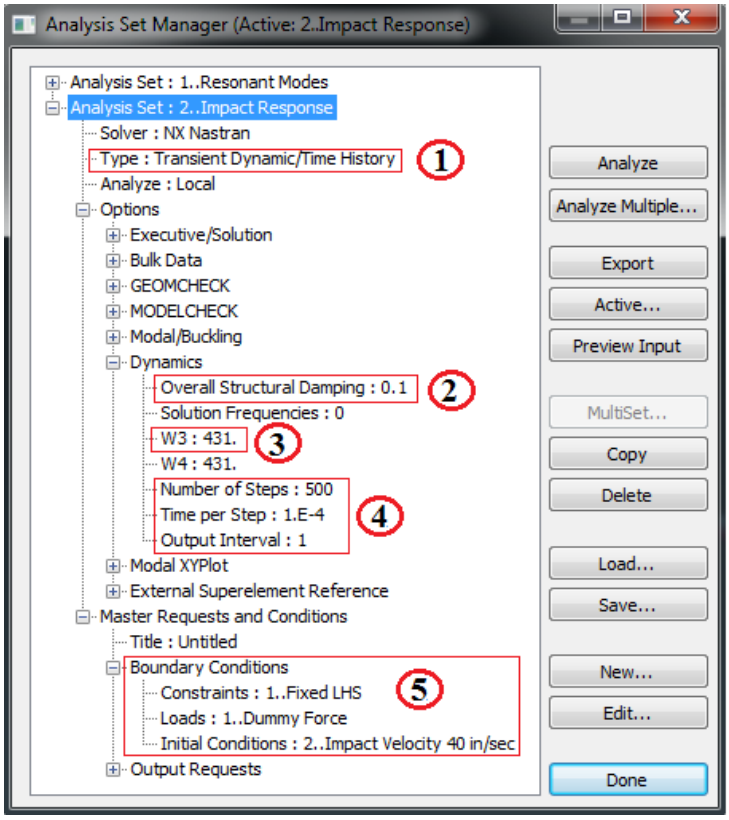
Processing and Viewing Transient Solution

Step 1: *Run Transient Thermal Solution.*

From the top menu bar: **Model – Load – Set** Select **2.. Impact Response**. Everything has been preprogrammed for the ***Transient Dynamic Solution***. Press **OK** to **ESC** and exit.

From the top menu bar select **Model – Analysis** and review the following key entries:

- Analysis Set: **1.. Impact Response**
  - ✓ Type: **Transient Dynamic/Time History**
- Dynamics
  - ✓ Overall Structural Damping **0.1**
  - ✓ Solution Frequencies **W3, W4 = 431 Hz**
  - ✓ Number of Steps **500**
  - ✓ Time per Step **$1.0e^{-4}$**
  - ✓ Output Interval **1**
- Boundary Conditions
  - ✓ Constraints: **1.. Fixed LHS**
  - ✓ Loads: **1.. Dummy Force**
  - ✓ Initial Conditions: **2.. Impact Velocity 40 in/sec**
- Output Results
  - ✓ Displacement: **1.. Rod End**
  - ✓ Velocity: **1.. Rod End**
  - ✓ Acceleration: **1.. Rod End**



Refer to the **Analysis Set Manager** shown at right. After verifying the entries in the dialog box show, **Select** Done **.**

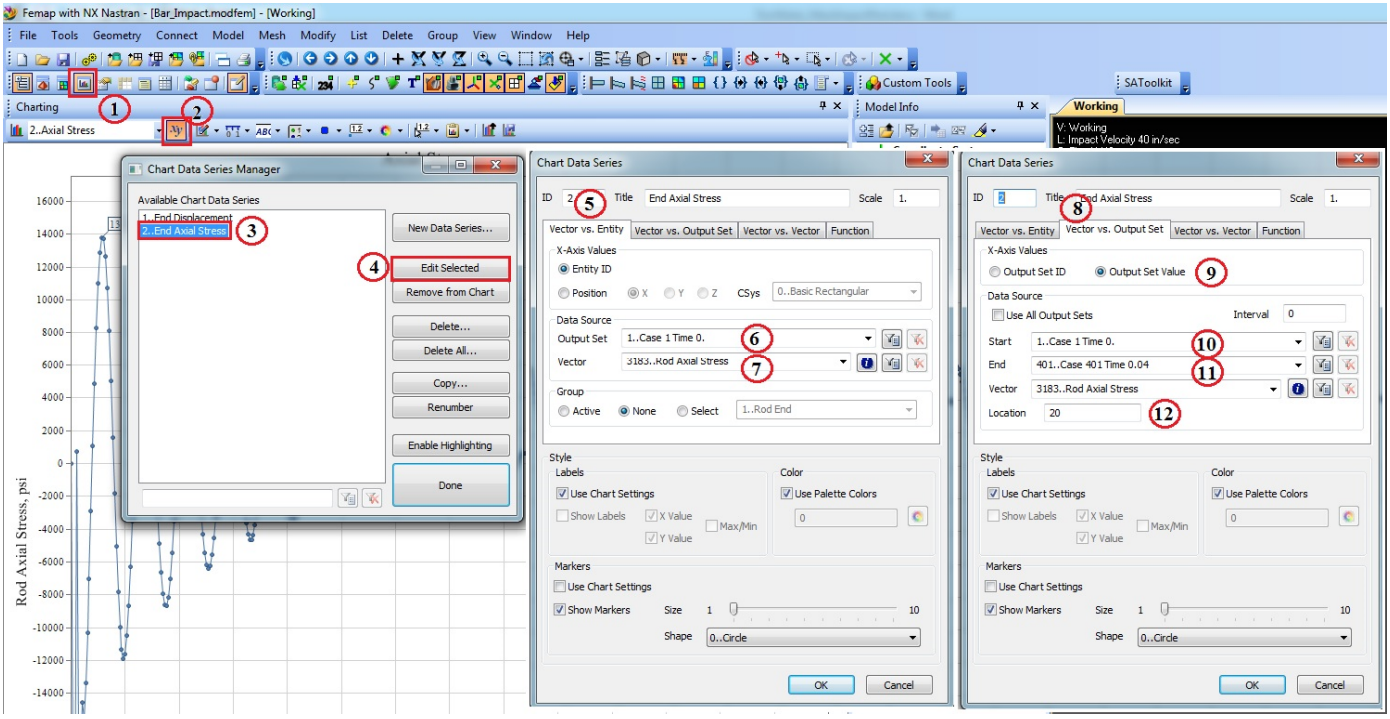
Next Select **File - Analyze**. Processing should begin to run and automatically read in results. The solution files are included with these run notes. Select "**File – Attach Results** and select output file "***Rod_Impact-Solution.xdb***".

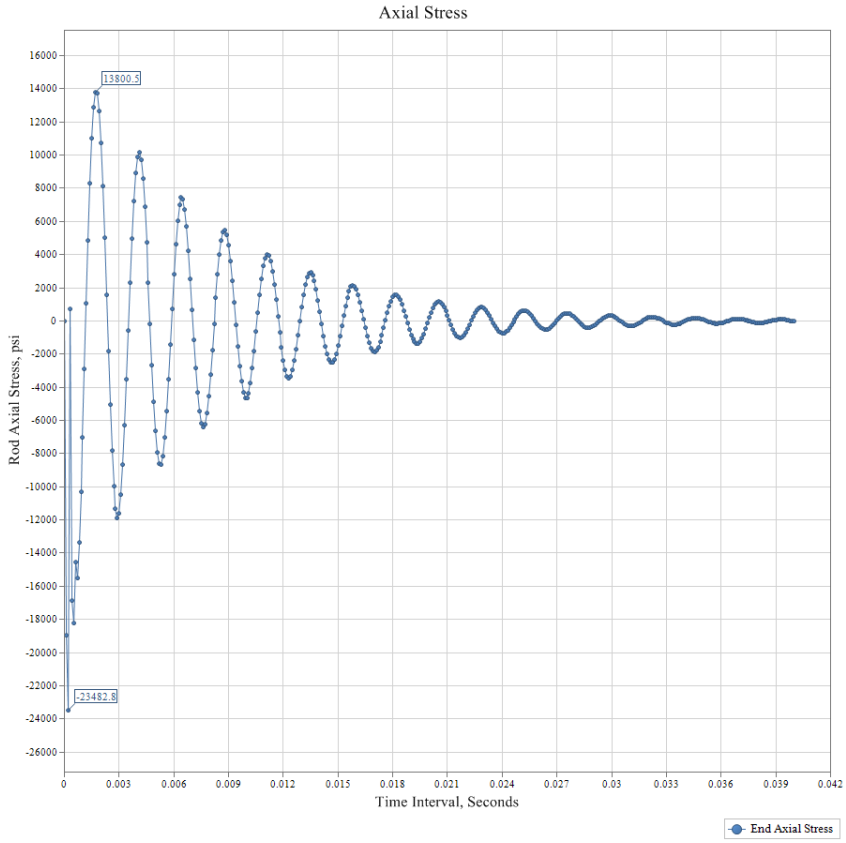
Step 2: *Post Processing Transient Graph of Axial Stress for End Element*

To open a Window for viewing graphical results select **Charting** from the LHS toolbar. I've stored all of the set-up parameters and pre-selected proper scaling for displaying axial stresses versus time in graphics form for the free end of the rod.

1.) Click on ***Chart Icon*** box.
2.) The next dialog box should be "***Select XY Data Series Manager***".
3.) Select "***End Axial Stress***
4.) Select "***Edit Selected***"
5.) Select "***Vector vs Entity***"
6.) For **Output Case**, select "***1..Case 1 Time 0***"
7.) For **Vector**, select "***3183.. Rod Axial Stress***"
8.) Select "***Vector vs Output Set***"
9.) Select "***Output Set Value***"
10.) For **Start**, select "***1..Case 1 Time 0***"
11.) For **End**, select, "***401..Case 401 Time 0.04***"
12.) For **Location**, select element "***20***"

A graph of axial stress as a function of time (seconds) for the element 20 at the free end of the rod model idealization should display similar to the one below. Similar graphical results are stored to show Velocities and Accelerations for the end of the bar **Node 21**.





For any questions you may have regarding this FAX/memorandum, please call at (714) 846-4235, E-Mail at **AppliedAT@aol.com**.

Regards,

David R. Dearth, P.E.

Appendix A

Run Notes for use with Patran

These run notes are highly condensed for use by experienced Patran users.

Patran users might find the following reference commands helpful.

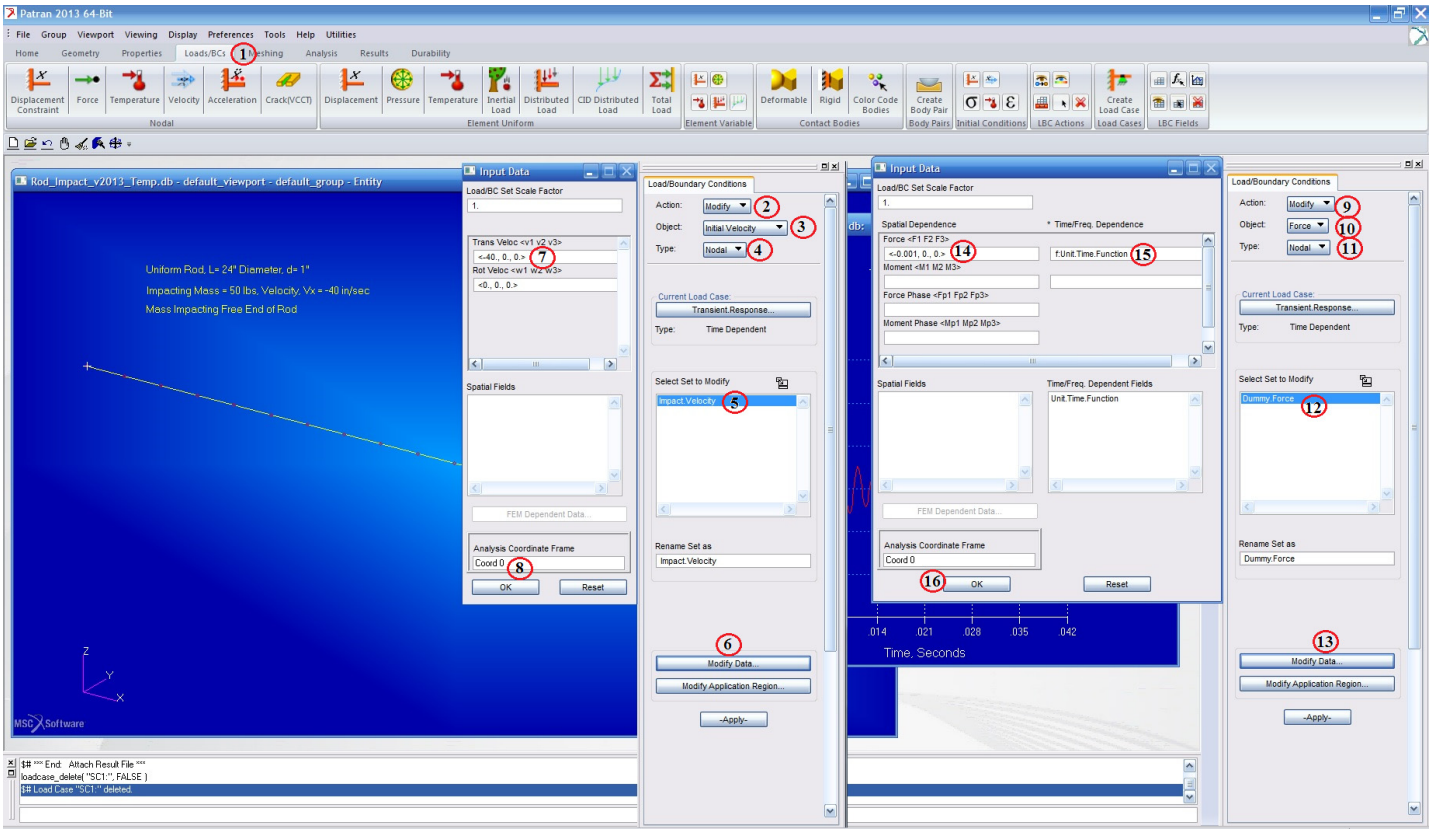
The following files are needed to review results: "***Rod_Impact_v2013.db***","***Rod_Impact-Solution.xdb***".

Review Impact Initial Conditions

To review load case options select:

- ✓ (1.) **Loads/BC**, (2.) **Modify** , (3.) **Initial Velocity**, (4.) **Nodal** , (5.) **Initial Velocity** , (6.) **Modify Data**, (7.) ***Trans Veloc <-40.,0.,0.>*** {Vx = -40 in/sec}, (8.) **OK**
- ✓ (9.) **Modify**, (10.) **Force** , (11.) **Nodal**, (12.) **Dummy Force** , (13.) **Modify Data**. (14.) ***Force <-0.001,0.,0.>*** , (15.) Time/Freq. Dependence **f.Unit Time Function** (16.) **OK**

See screen print below.



To inquire on the concentrated mass select **Properties – Modify – Concentrated.Mass – Modify Properties** and note mass properties. **Mass** = 50/386.4 = **0.1294 lb-sec^2/in**.

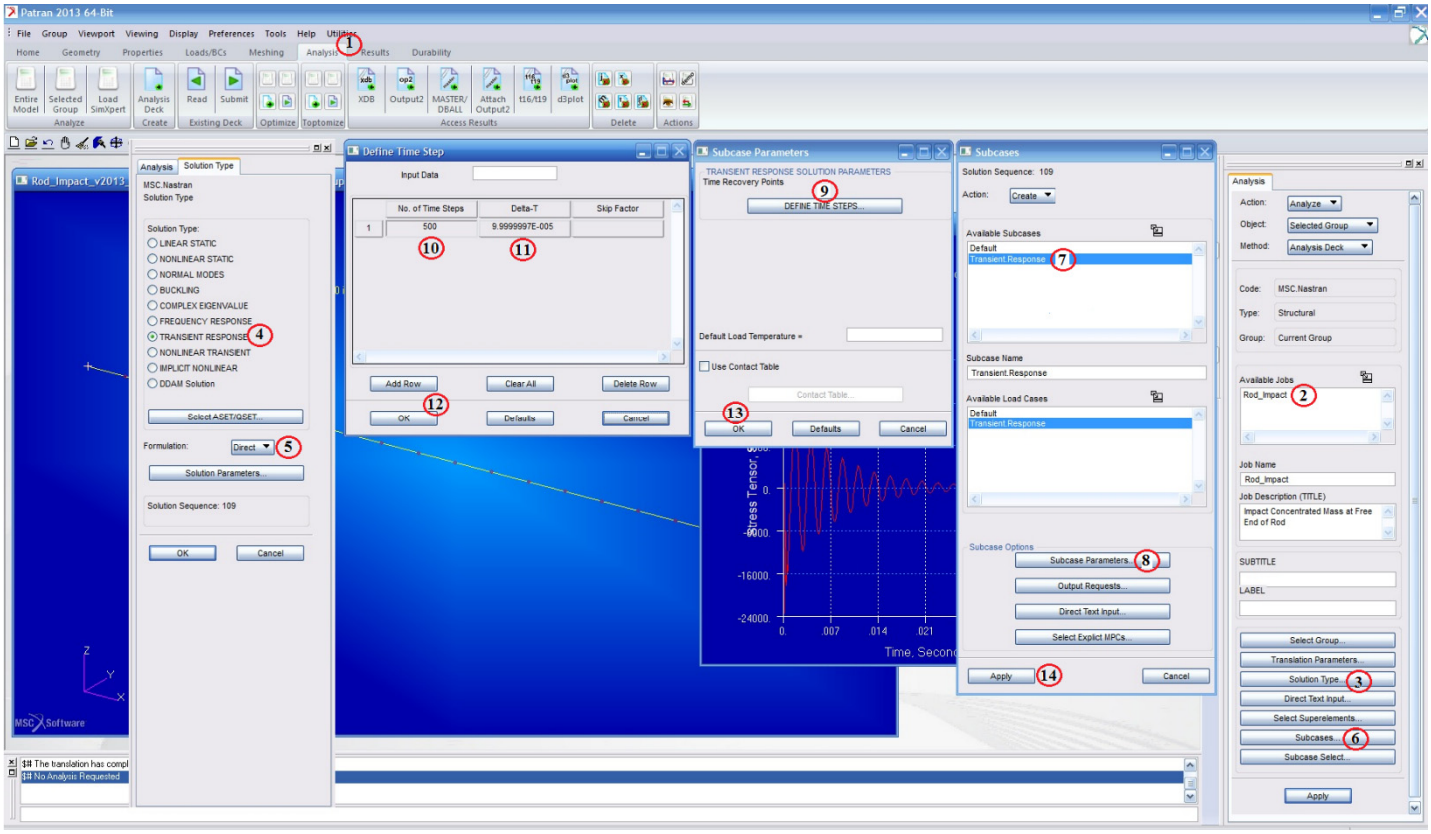
To inquire on the rod **Properties – Modify – Uniform.Rod – Modify Properties** and note **Area = 0.7854 in^2.**

Review Analysis Run Options

To inquire on the analysis run options select:

- ✓ (1.) **Analysis**, (2.) "***Rod_Impact***", (3.) **Solution Type**. Note the following:
- ✓ (4.) **Transient Response** (Solution Sequence 109) , (5.) **Direct**.
- ✓ (6.) **Subcases** , (7.) **Transient Response** , (8.) **Subcase Parameters** , (9.) **Define Time Steps** , Select (10.) No. of Time Steps **500** , (11.) Delta-T **0.0001** , (12.) **OK** , , (13.) **OK** , (14.) **Apply**

See screen print below.



Review Results

To display the time history analysis results:

- ✓ (1.) **Results**, (2.) **Graph**
- ✓ (3.) **Modify** , (4.) **Graph** , (5.) **Existing Graph Plots** , (6.) Select **Transient** , (7.) Transient
- ✓ (8.) Select Results, (5.) **… Time = 0.0 to … Time = 0.42**, (10.) **Stress Tensor**, (11.) **X Component**
- ✓ (12.) Target Entity, (13.) **Nodes** , (14.) **Node 21**
- ✓ (15.) Display Attributes, (16.) X Axis **Times, Seconds** , (17.) Y Axis **Stress Tensor, Sx** , (18.) **Apply**

See screen print below.