Ansys Mechanical Linear and Nonlinear Dynamics

# WS 03.2: Bladed Disk

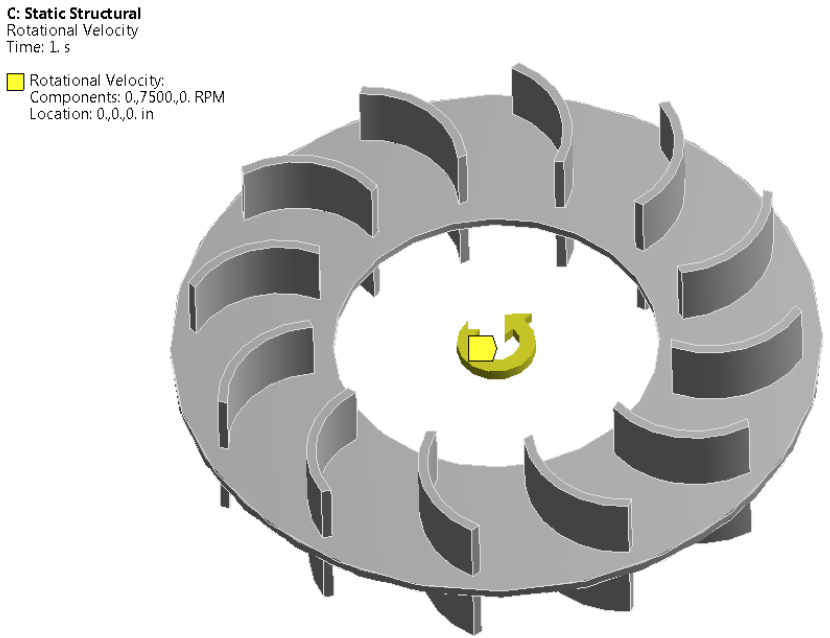
Release 2022 R2

Please note:

- These training materials were developed and tested in Ansys Release 2022 R2. Although they are expected to behave similarly in later releases, this has not been tested and is not guaranteed.
- The screen images included with these training materials may vary from the visual appearance of a local software session.
- Although some workshop files may open successfully in previous releases, backward compatibility is somewhat unlikely and is not guaranteed.

# Workshop 03.2 - Goals

- Upon completion of this workshop, you will be able to set up a Pre-stressed Modal analysis and understand how the pre-stress affects the natural frequencies.
  - Our goal is to determine the first 6 natural frequencies and mode shapes of the rotating bladed disk as shown below and compare them against the modes for the same disk at rest.
  - The disk is manufactured from Titanium and experiences a rotational velocity of 7500 RMP.

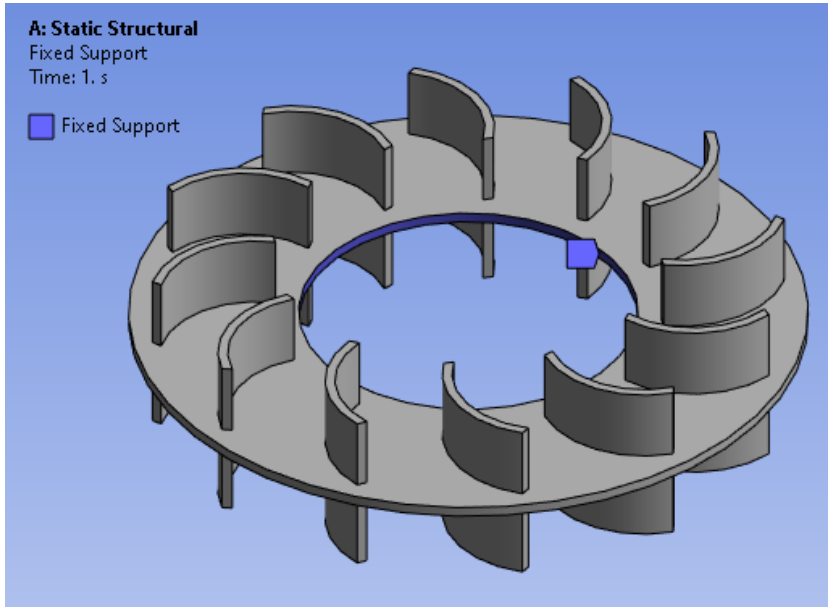


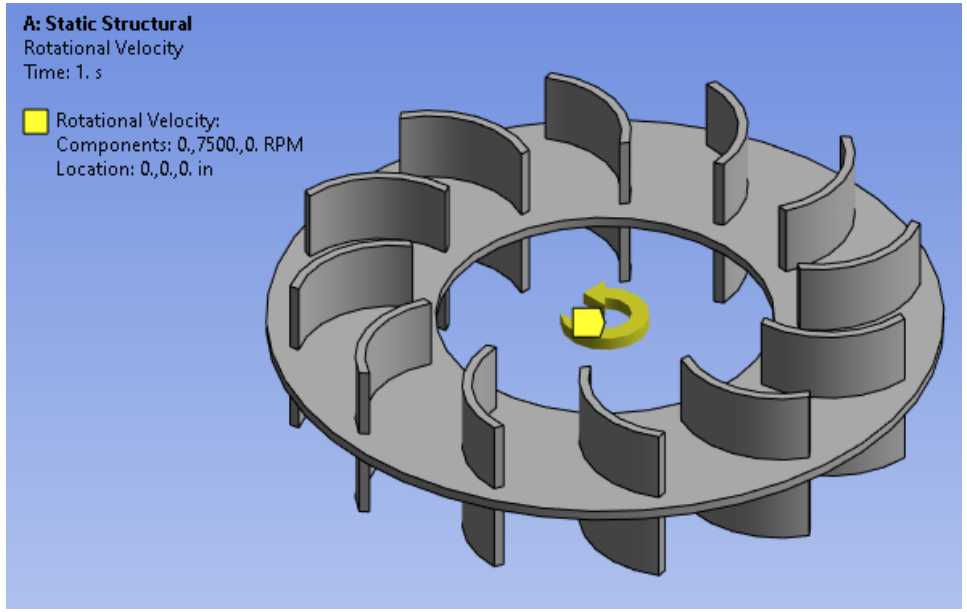
# Workshop 03.2 – General Model Setup

- Begin a new Workbench session and, from the project schematic, insert a new Static Structural system.
- Import the Geometry file "**Bladed_disk.stp**"
- Edit the Engineering Data cell.
  - add Titanium Alloy from the General Materials library to Engineering Data
- Drop a Modal system onto the Solution cell of the Static Structural.
  - This transfers the pre-stress effects to the Modal analysis
- Edit the Model cell to open the Mechanical application.
  - Units:
    - US Customary (in, lbm, lbf, °F, s, V, A)
    - Degrees
    - RPM
  - Assign Part material - Titanium Alloy

# Workshop 03.2 – Defining the Pre-stress Condition

- Constrain the center hub of the disk (surface) with a Fixed Support.
- Apply a rotational velocity about the axis of the disk.
  - Set the Y Component magnitude to 7500 RPM.

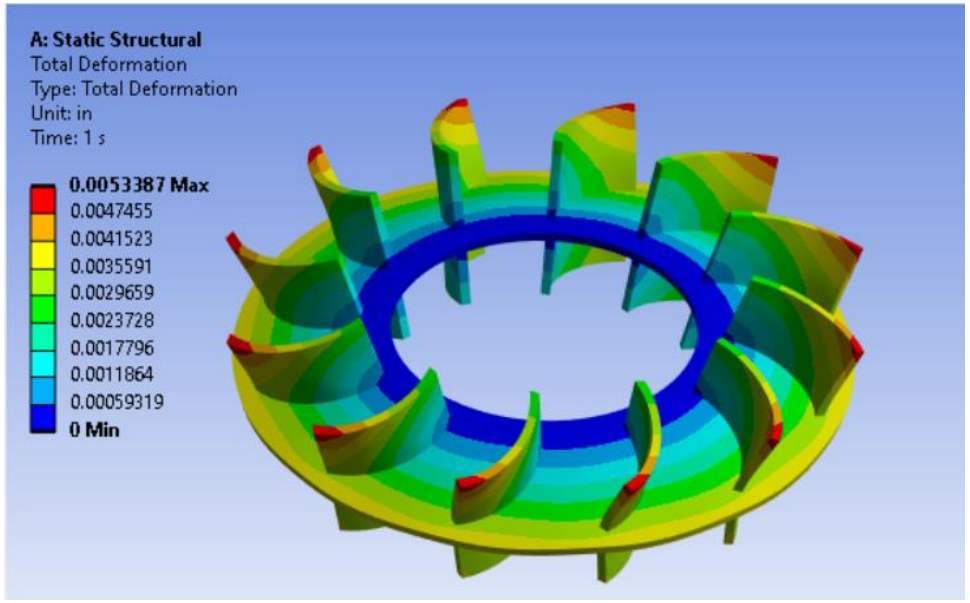


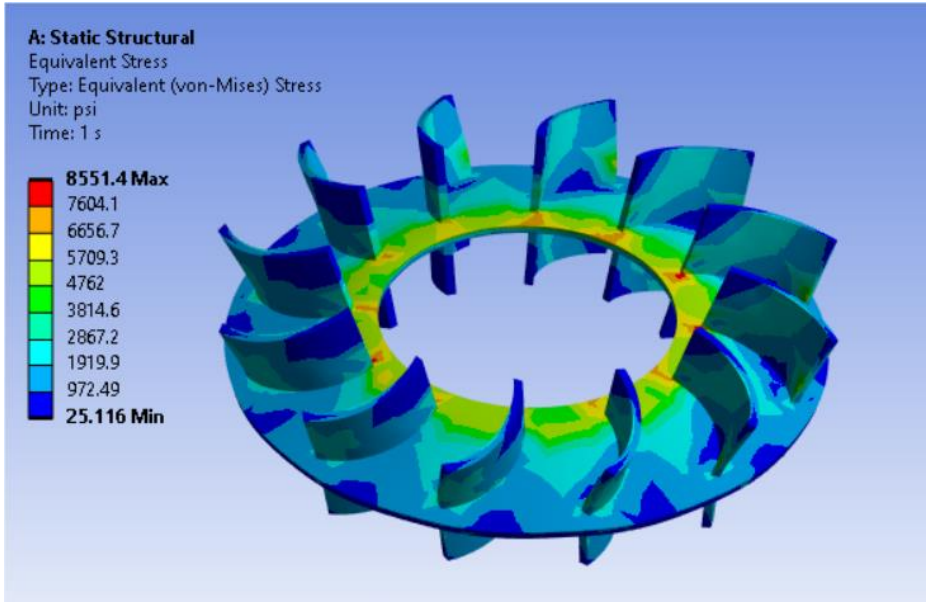



# Workshop 03.2 - Static Solution

*Note: your result magnitudes may vary slightly throughout this workshop due to mesh and software release differences.*

- Solve the Static Structural model.
- Review the results for Total Deformation and Equivalent Stress (images below are from the underside of the disk).

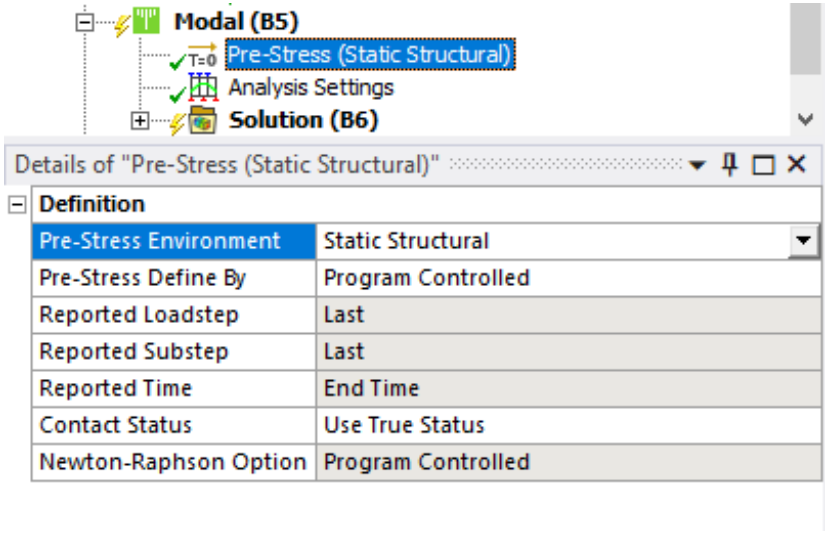


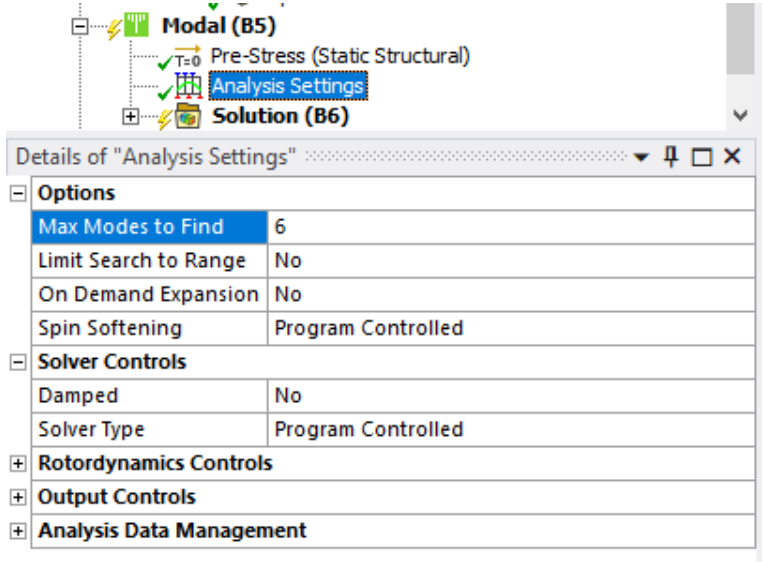



# Workshop 03.2 - Modal Solution

- Notice the Modal branch contains a Pre-Stress item referencing the Static Structural Solution
- Check the Details of Modal Analysis Settings:
  - Accept the default for Max Modes to Find = 6

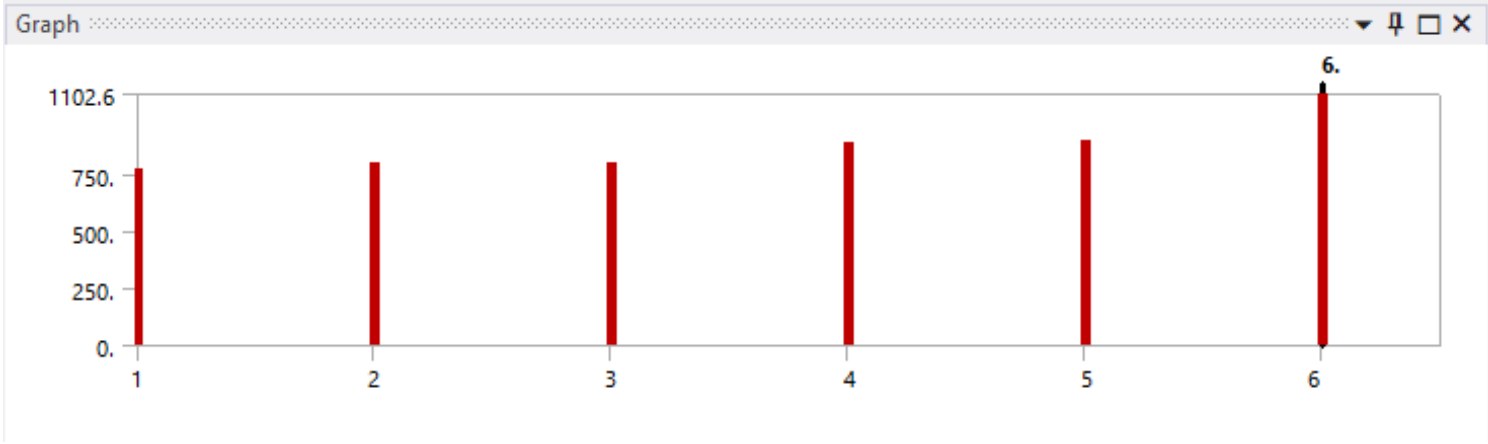
- Solve the Modal analysis.

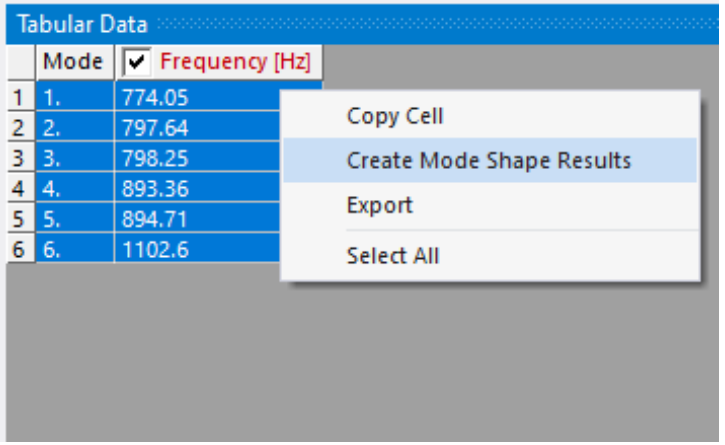


# Workshop 03.2 - Results

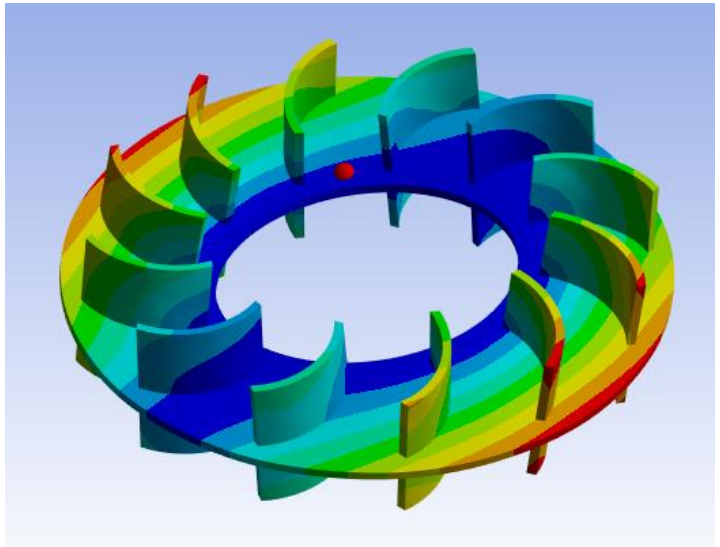
- After the modal solution is complete, review the modal shapes for each frequency.
  - Select the Modal Solution branch of the outline
  - Select the Frequency column of the Tabular Data
  - Right-mouse-button, Create Mode Shape Results
  - Evaluate Results

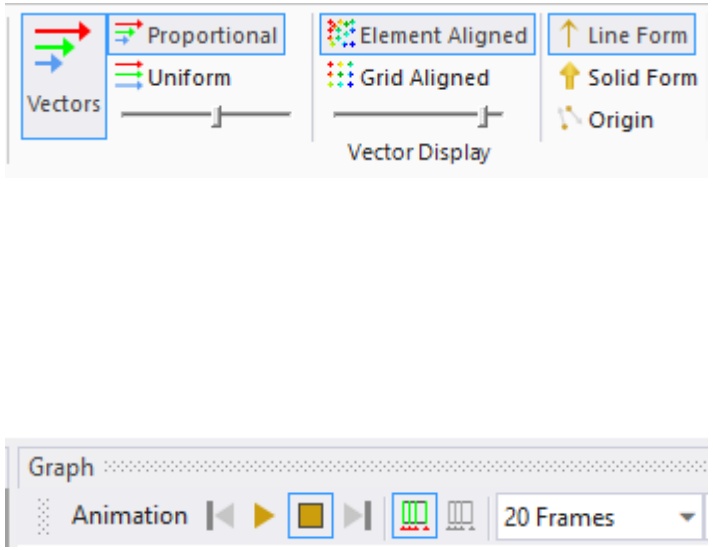


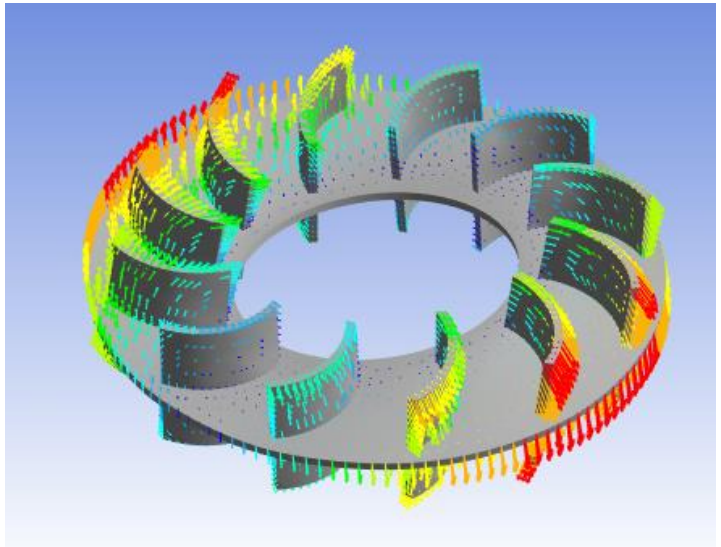



# Workshop 03.2 - Results

- Review the deformation results for each mode:
  - Animate the mode from the Graph window.
  - Make a note of the natural Frequency of the first mode: Max Indicated Freq = _____Hz
- Experiment with the Vector Graphics and (vector) scale slider. Animation and rotation can also be performed on Vector plots.

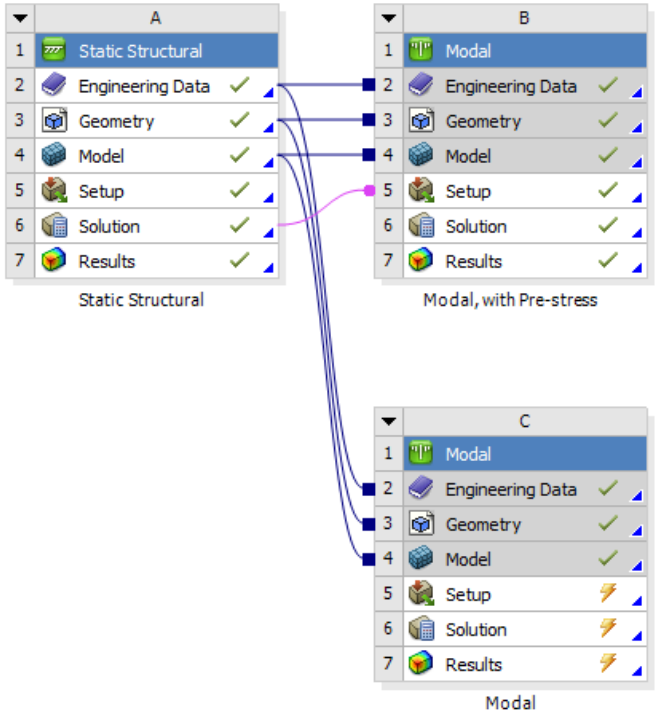




# Workshop 03.2 – Set up for Disk at Rest

- Return to the Project.  Drag and Drop another Modal Analysis on to the Model cell of the Static Structural.
  - This will share only the Geometry and Mesh.
  - Pre-Stress effects will not be included in this model and will mimic the disk at rest.
- Return to Mechanical

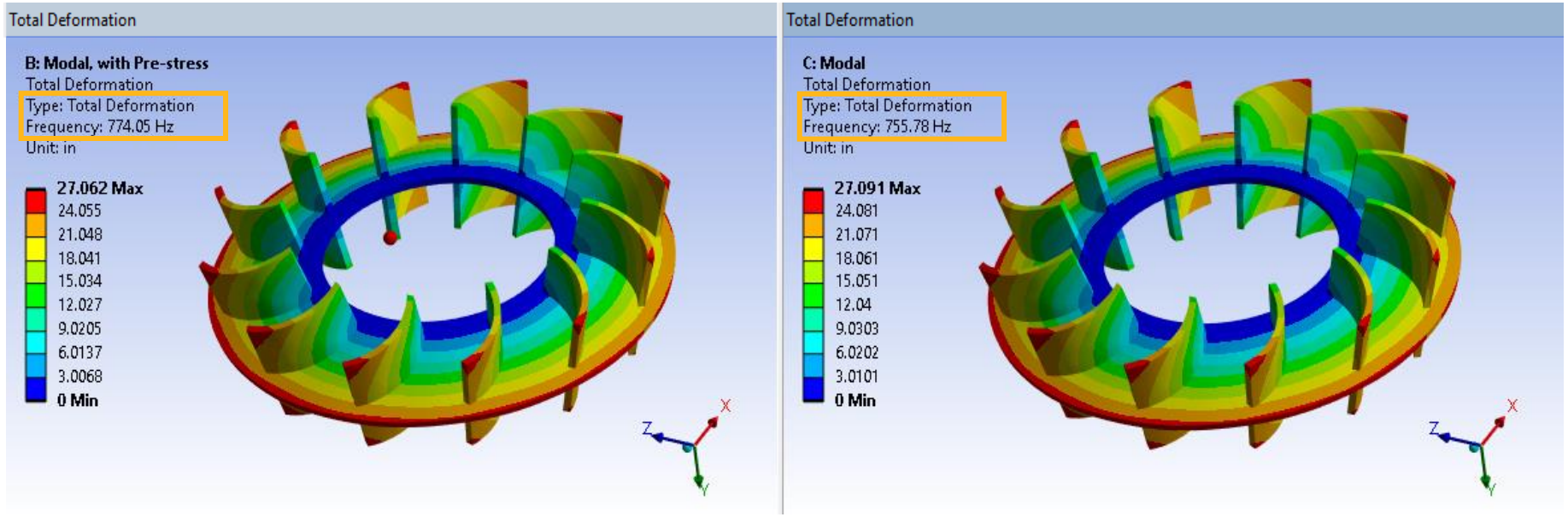


# Workshop 03.2 – Apply Fixed Support in Modal (C5)

- Apply a Fixed Support on the inner circumference of the disk as in the Static Structural analysis or drag/drop the one from the Static Structural branch.
  - We'll run this solution without the Rotational Velocity.
- Solve the Modal analysis

# Workshop 03.2 – Compare Results

- When the solution is complete, add and review deformation plots for each mode shape, comparing them to those obtained from the pre-stressed results of the spinning disk.
- Results here are shown for the first mode.




**Spinning Disk** **At Rest**

**End of presentation**