Static and Modal Analysis of a Five Spoke, 18" Alloy Wheel

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Problem Description

Properties:

- Five Spoke Aluminum Alloy Wheel
- 18” Diameter
- Young’s Modulus E = 71 GPA
- Poisson Ratio v = 0.33
- Density ρ = 2770 kg/m^3

Static Analysis:

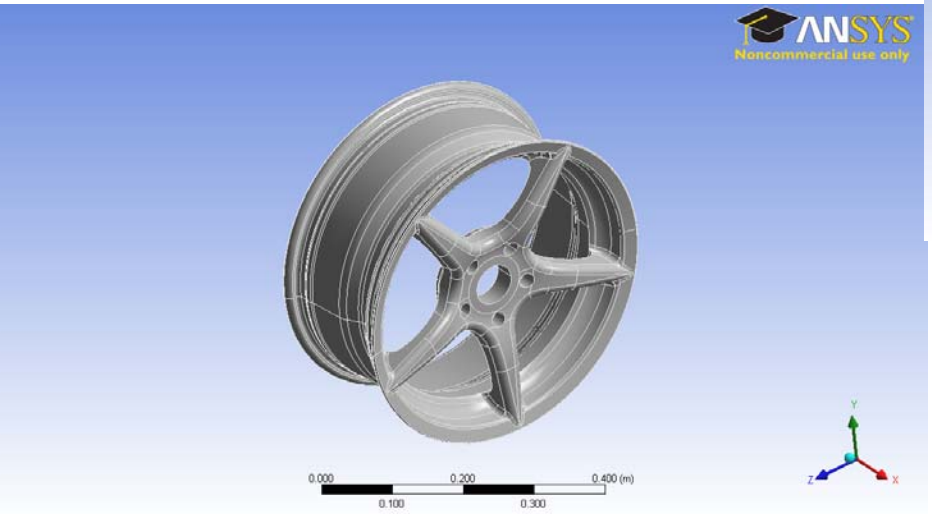
- 105.392 rad/s (55 MPH)
- 134.135 rad/s (70 MPH)
- 172.46 rad/s (90MPH)

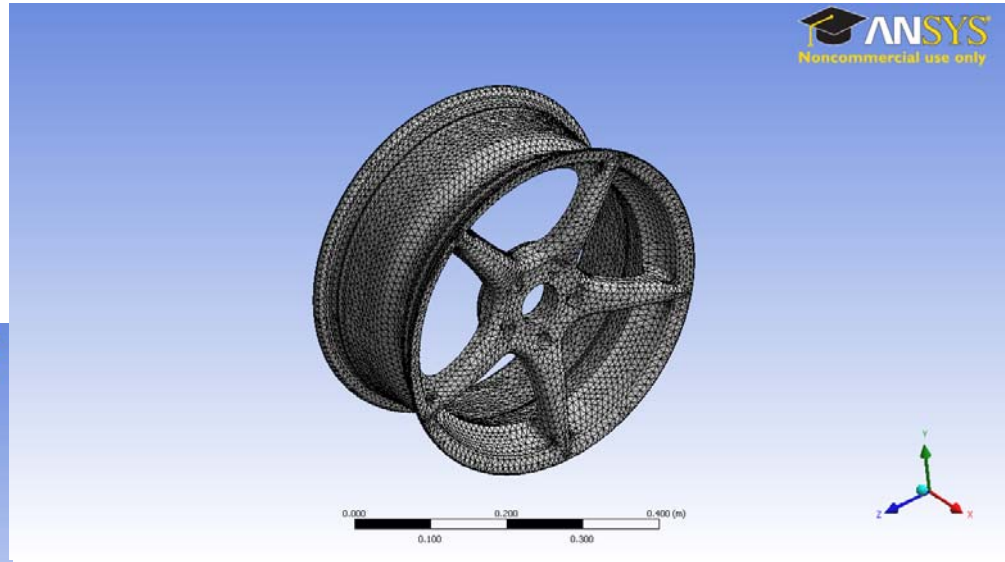
Modal Analysis:

- First Ten Modes

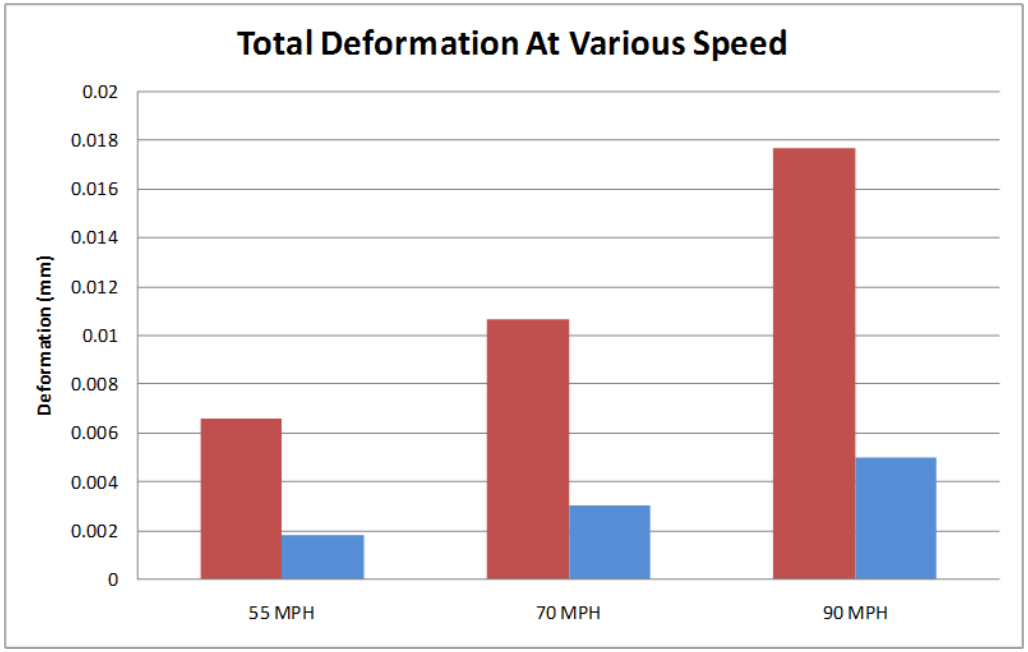
Meshing

- Method: Tetrahedrons
- Element Size:
  - 0.01 m
  - 0.03 m
  - 0.05 m





Deformation



Total Deformation	105.392 rad/s (55 MPH)	134.135 rad/s (70 MPH)	172.46 rad/s (90 MPH)
Max (mm)	0.0066027	0.010695	0.01768
Min (mm)	0.0018627	0.0030173	0.0049878

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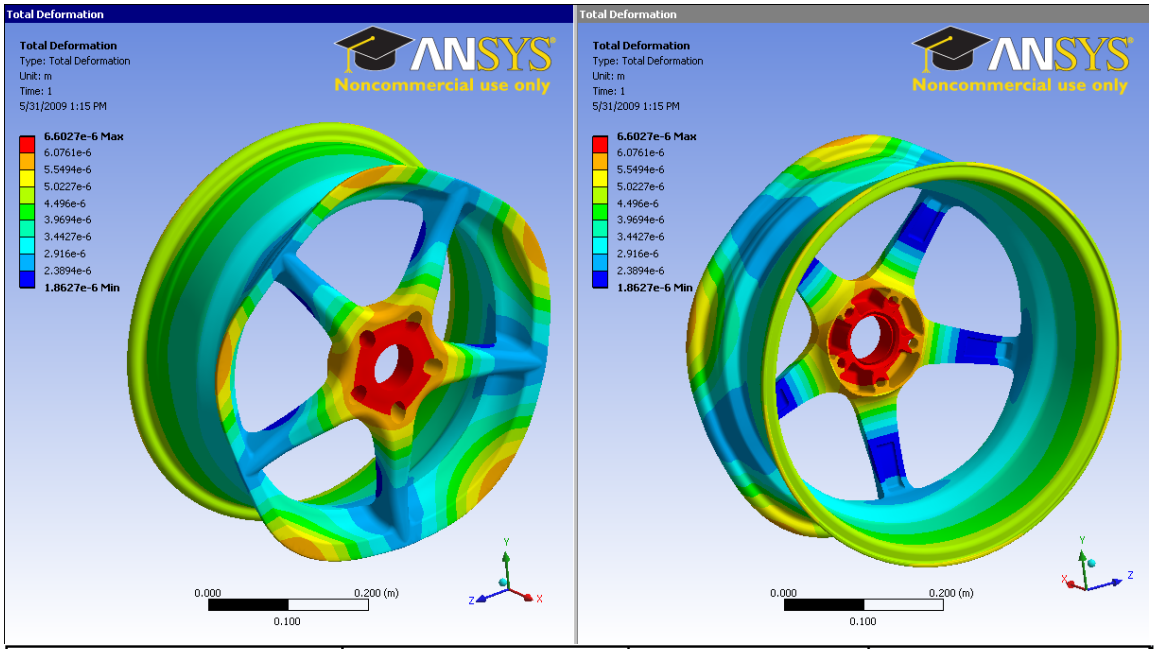
Deformation



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Max (mm)	0.0066027	0.010695	0.01768
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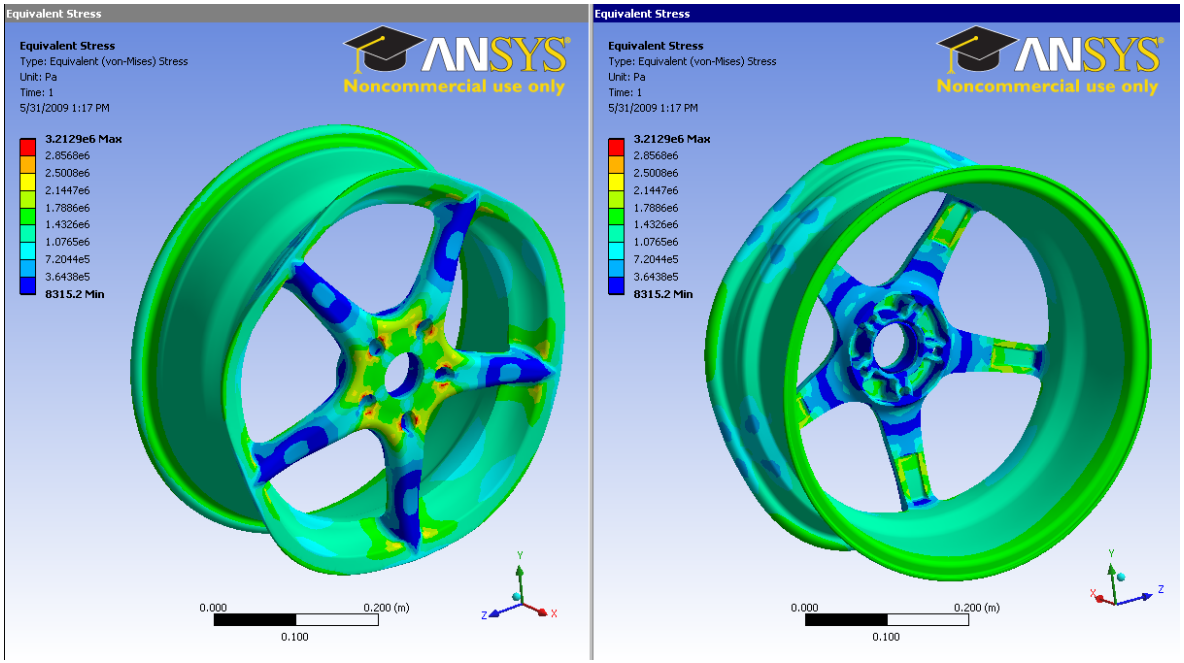
Stress



Equivalent Stress	105.392 rad/s (55 MPH)	134.135 rad/s (70 MPH)	172.46 rad/s (90 MPH)
Max (Pa)	3212900	5204300	8603100
Min (Pa)	8315.2	13469	22266

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Modal Analysis

No.	Frequency (Hz)		
	Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
1	305.58	308.24	320.52
2	305.62	308.36	321.18
3	661.33	668.88	695.96
4	661.93	668.96	696.47
5	870.27	879.92	901.51
6	1103.3	1120.4	1177.1
7	1104.6	1121.1	1180.3
8	1188.1	1201	1260.2
9	1188.5	1201.7	1269.8
10	1334.8	1348.7	1410.1

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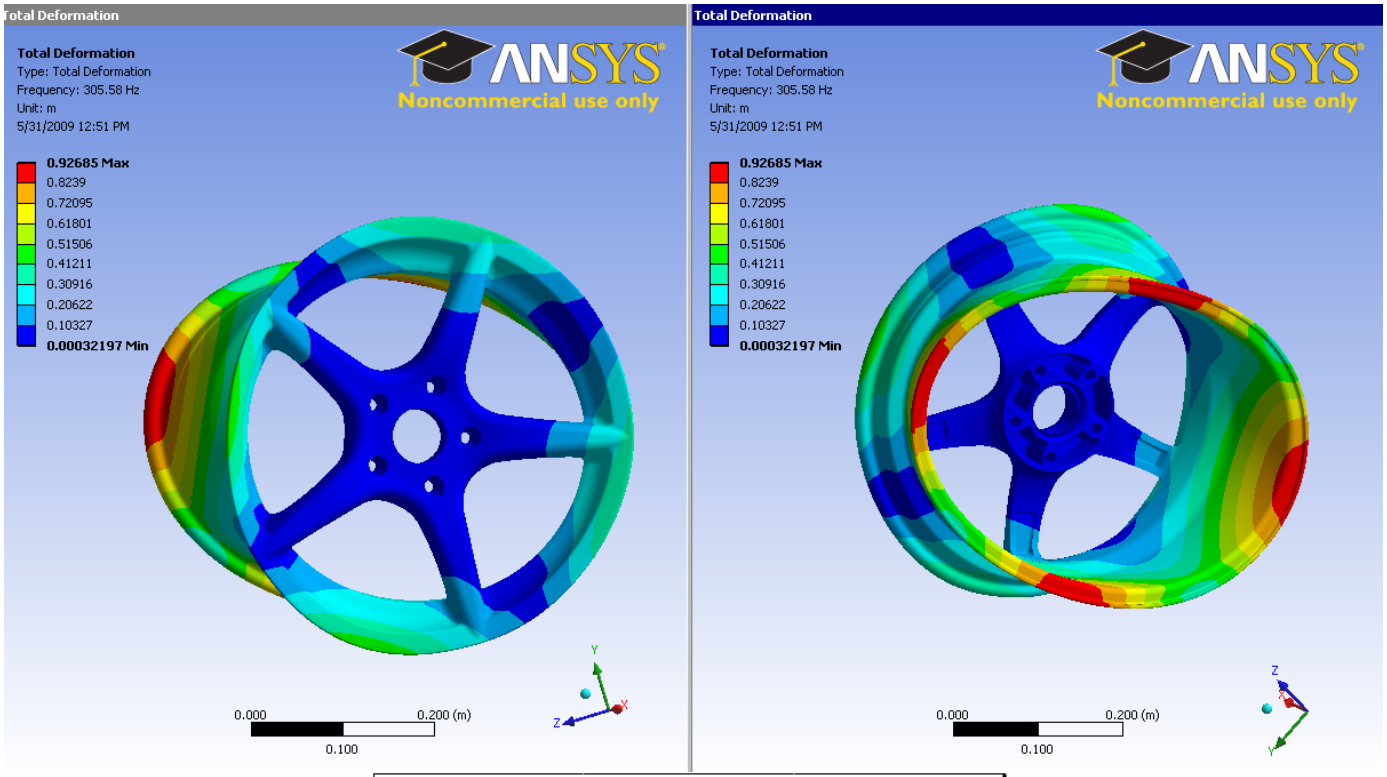
First Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
305.58	308.24	320.52

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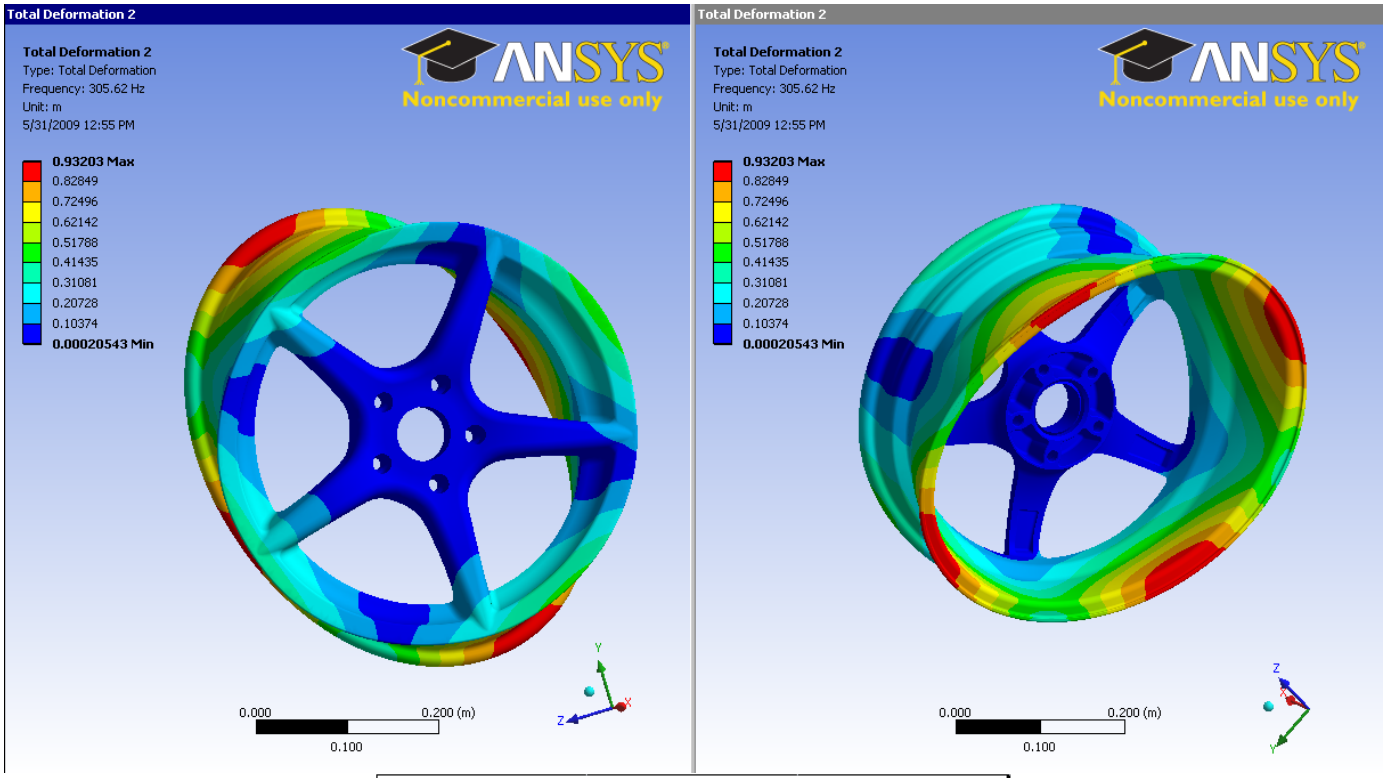
Second Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
305.62	308.36	321.18

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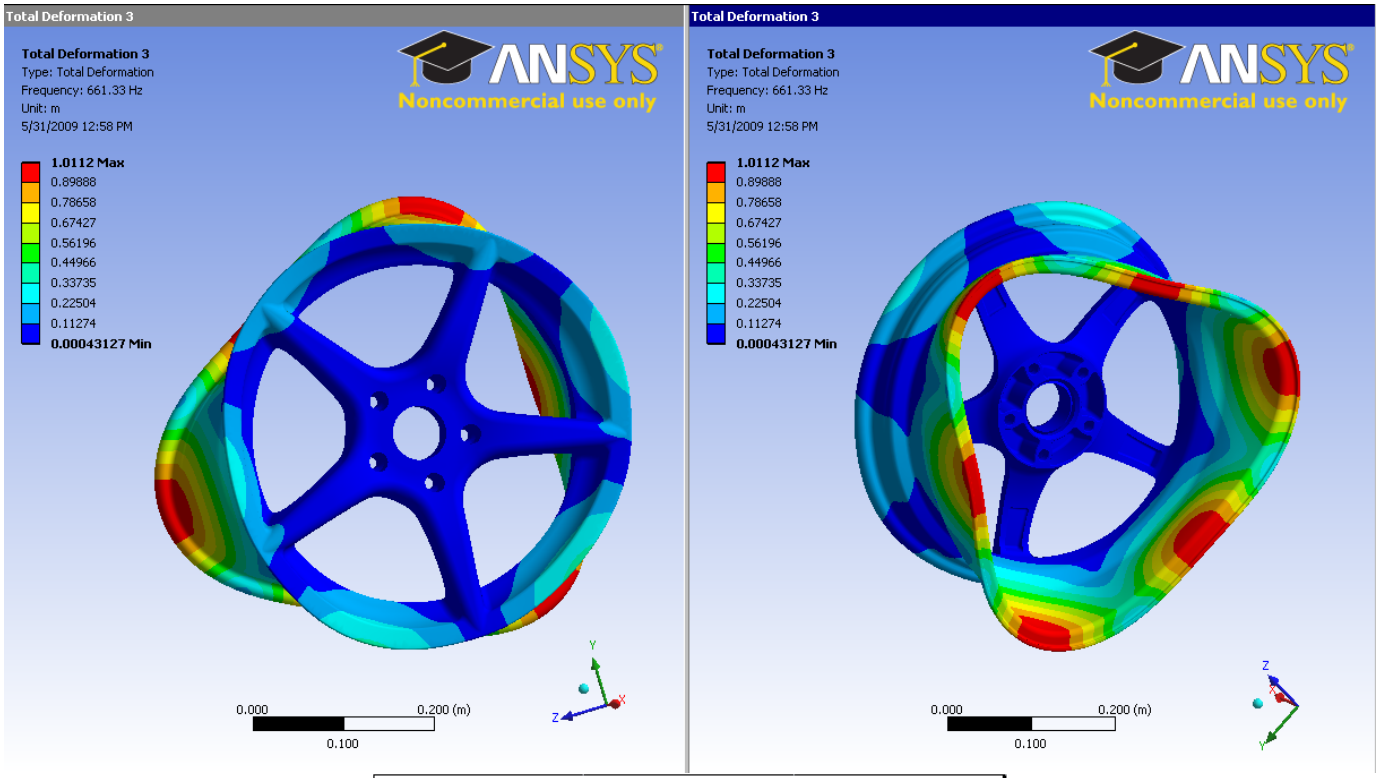
Third Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
661.33	668.88	695.96

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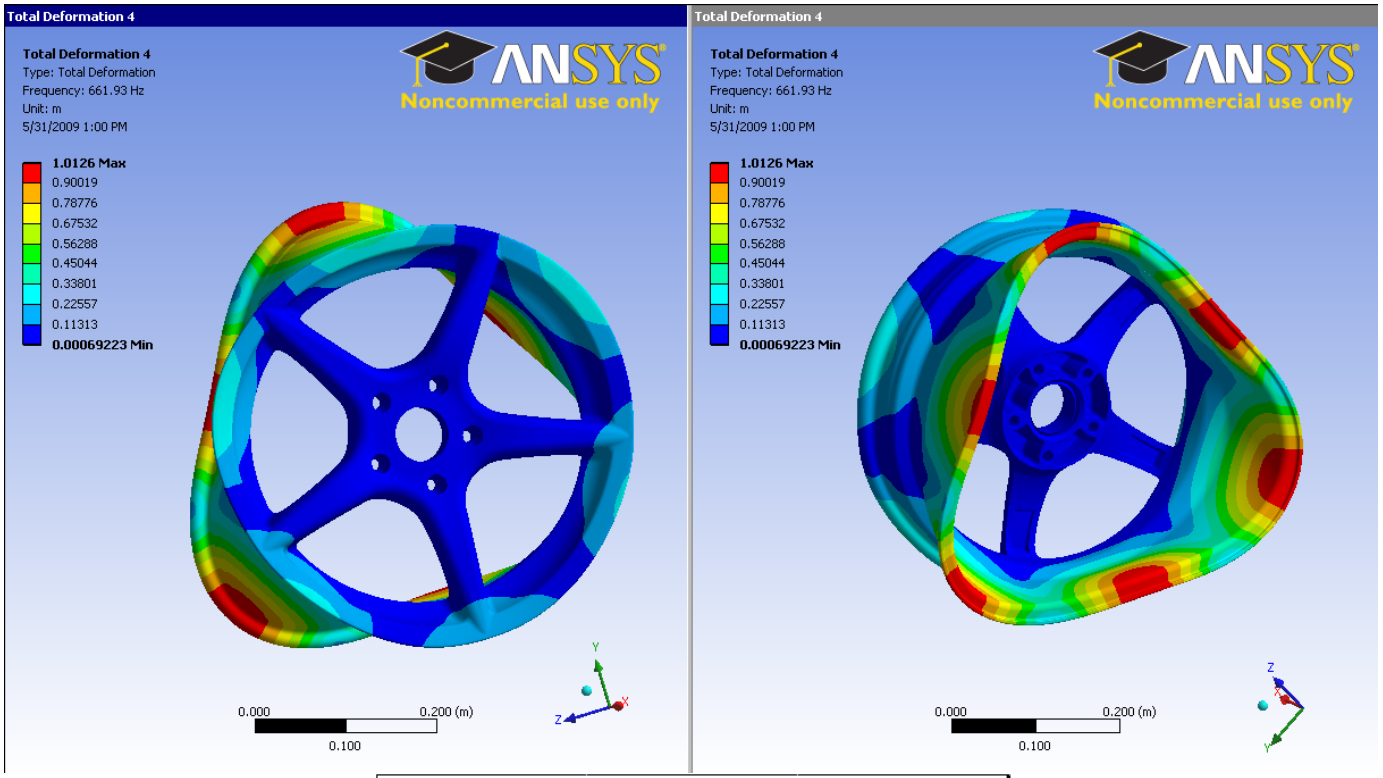
Fourth Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
661.93	668.96	696.47

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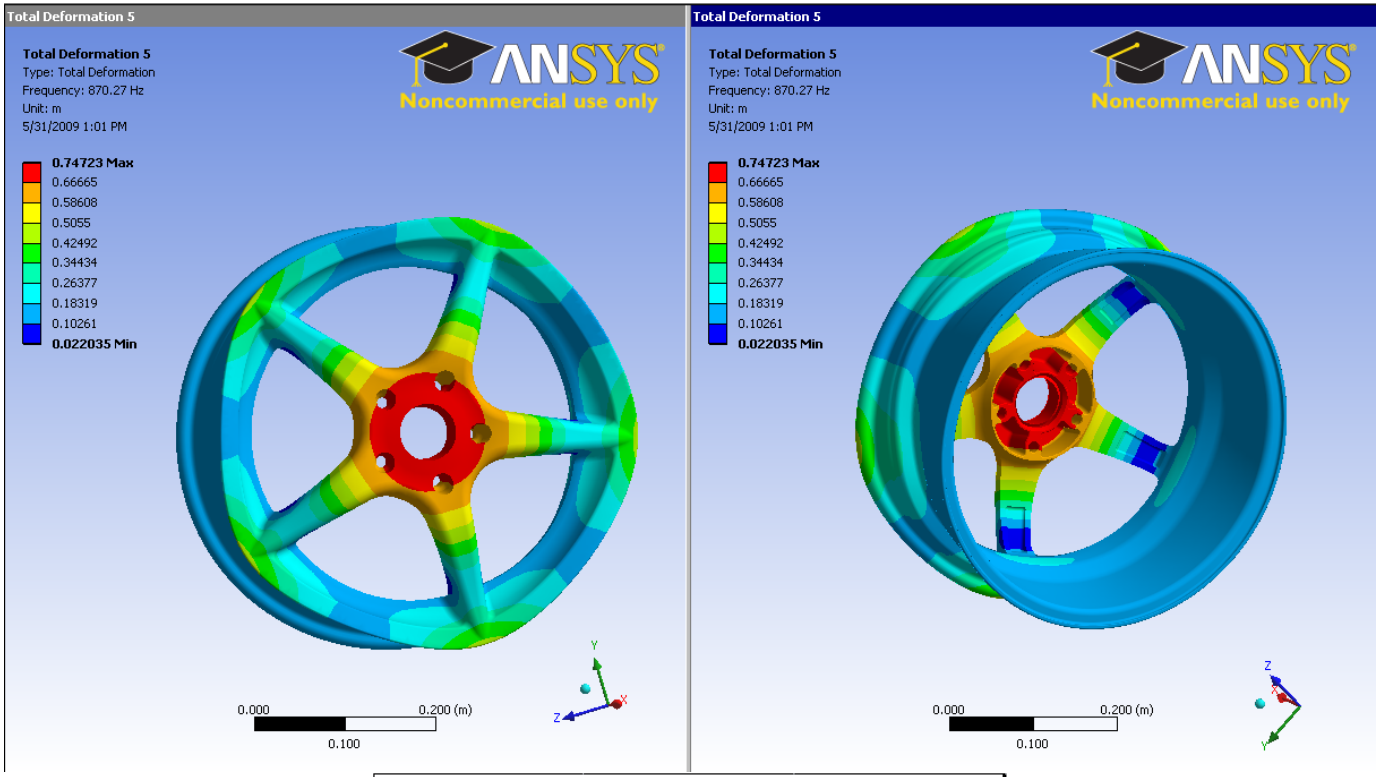
Fifth Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
870.27	879.92	901.51

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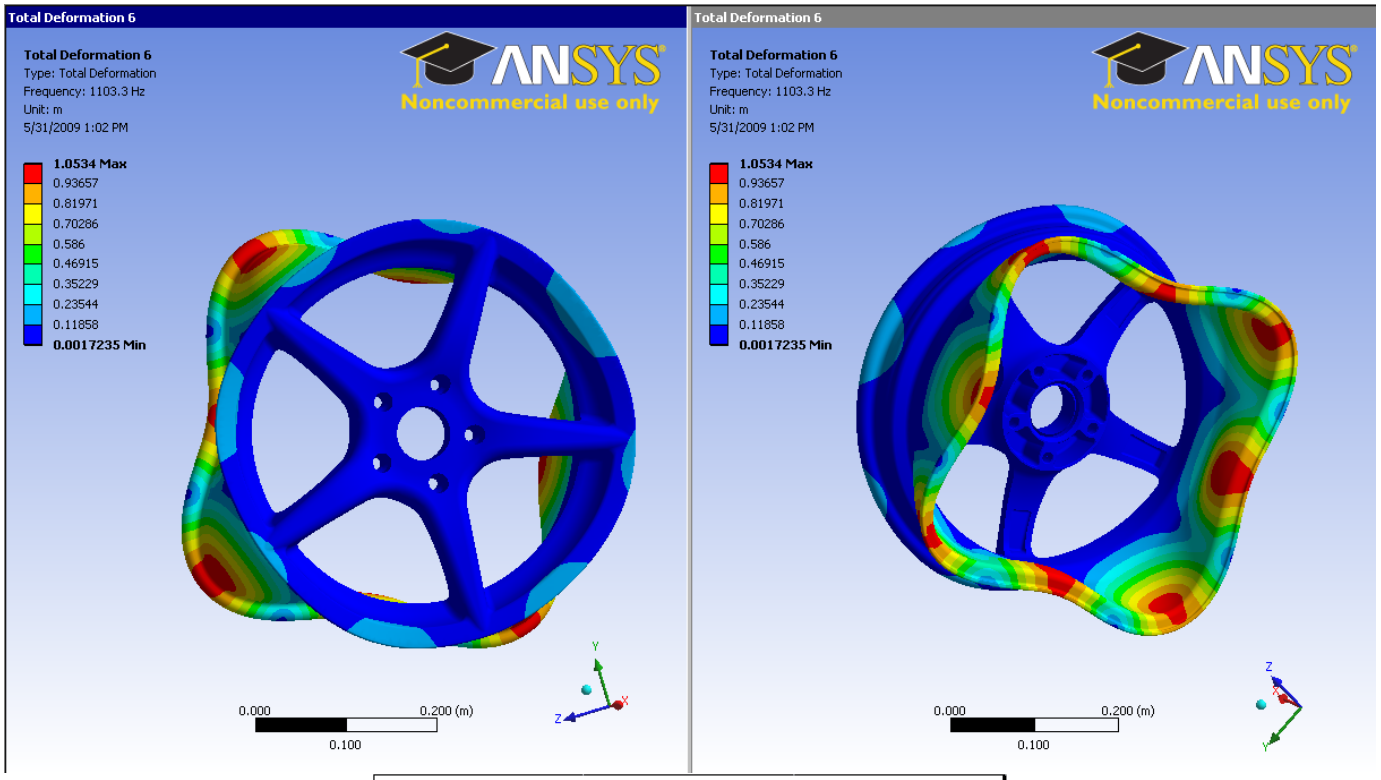
Sixth Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
1103.3	1120.4	1177.1

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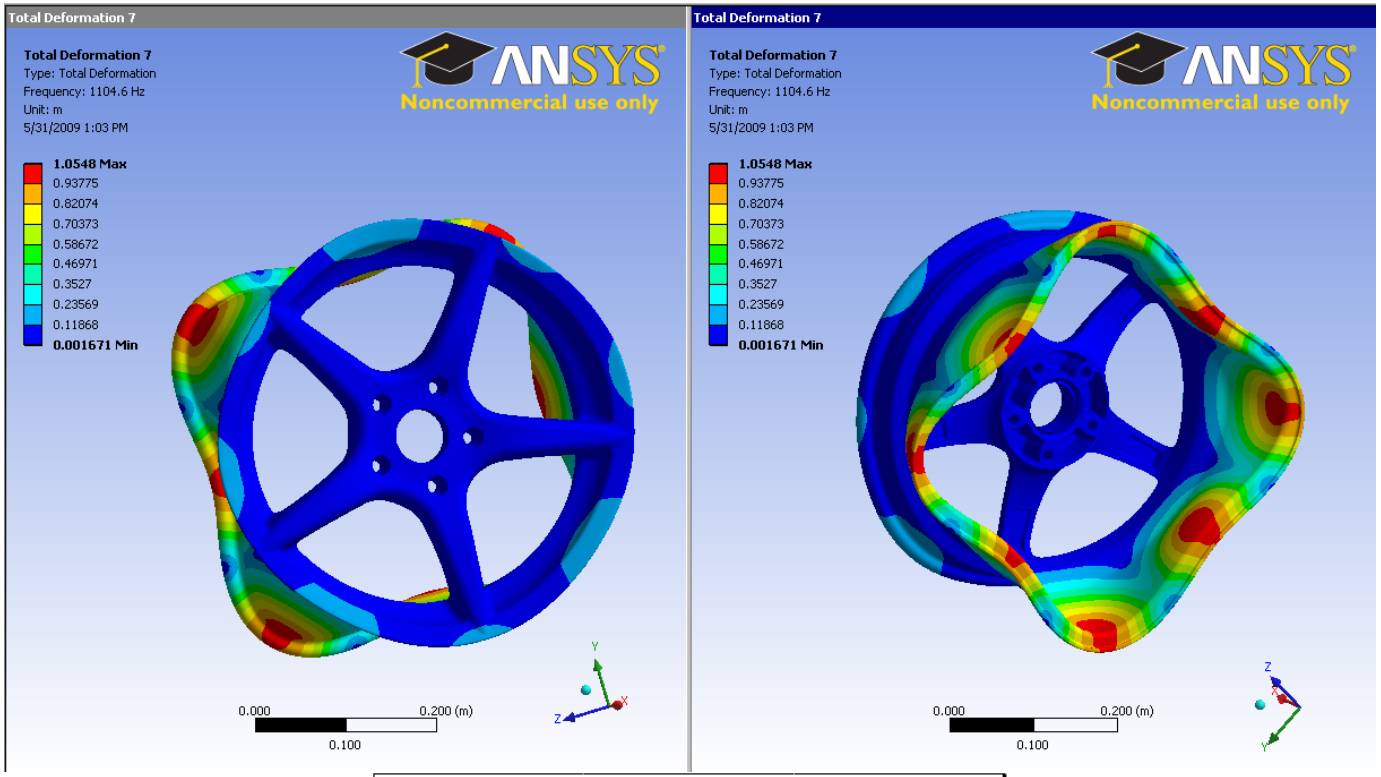
Seventh Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
1104.6	1121.1	1180.3

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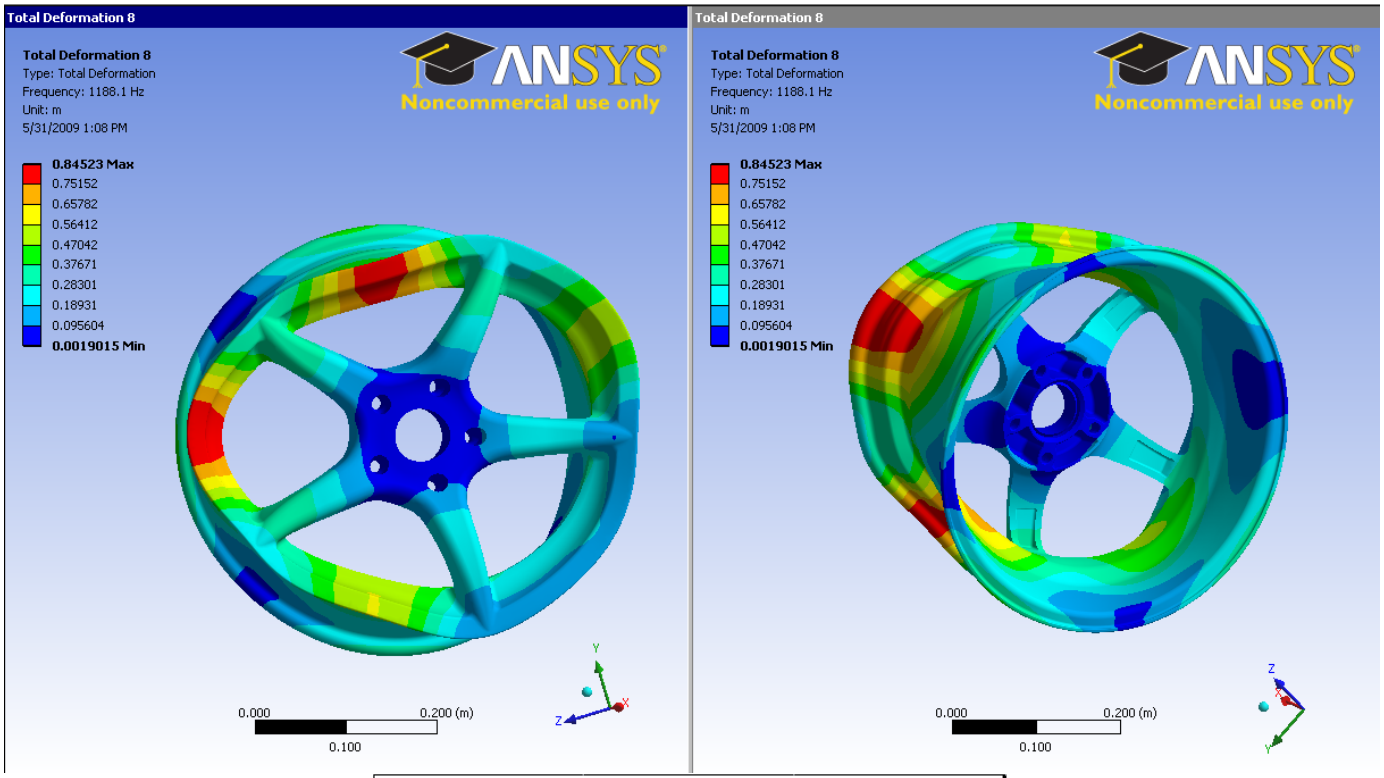
Eighth Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
1188.1	1201	1260.2

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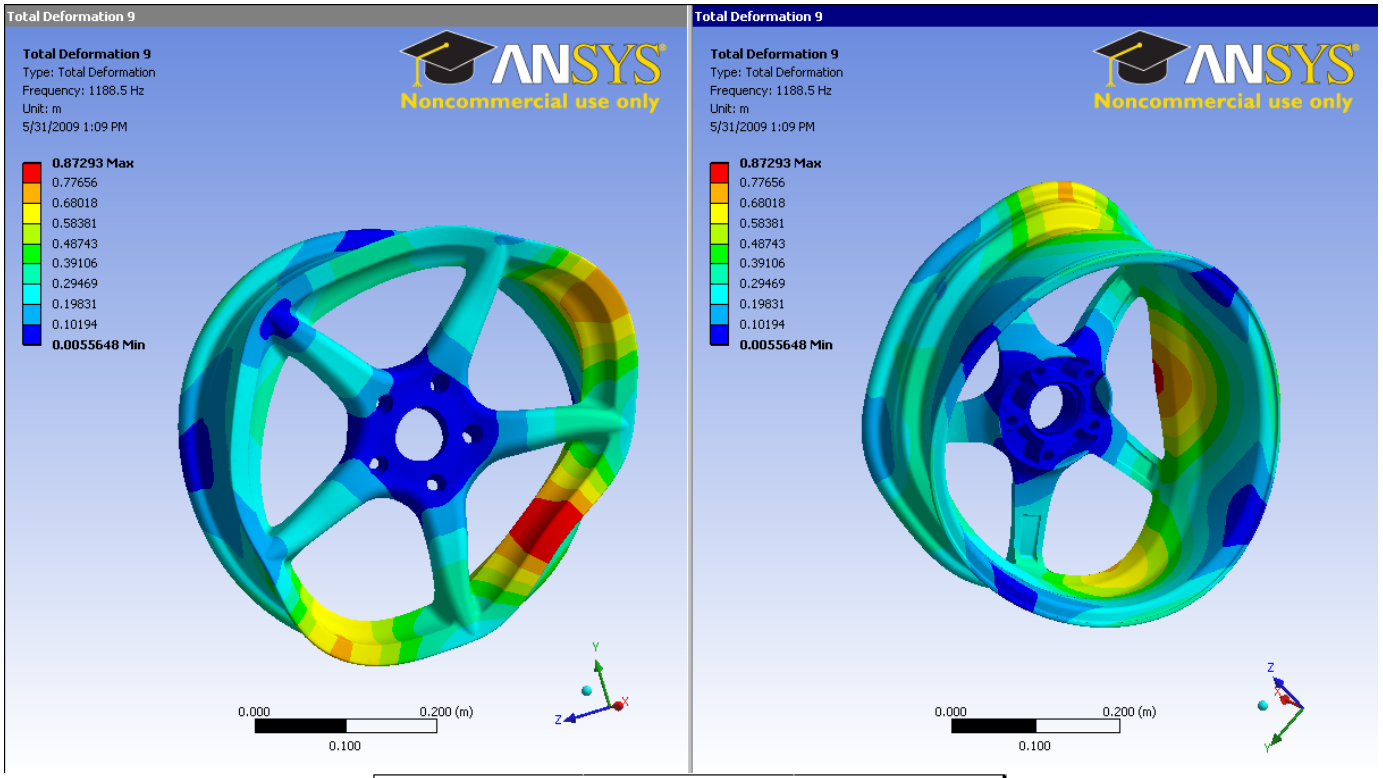
Ninth Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
1188.5	1201.7	1269.8

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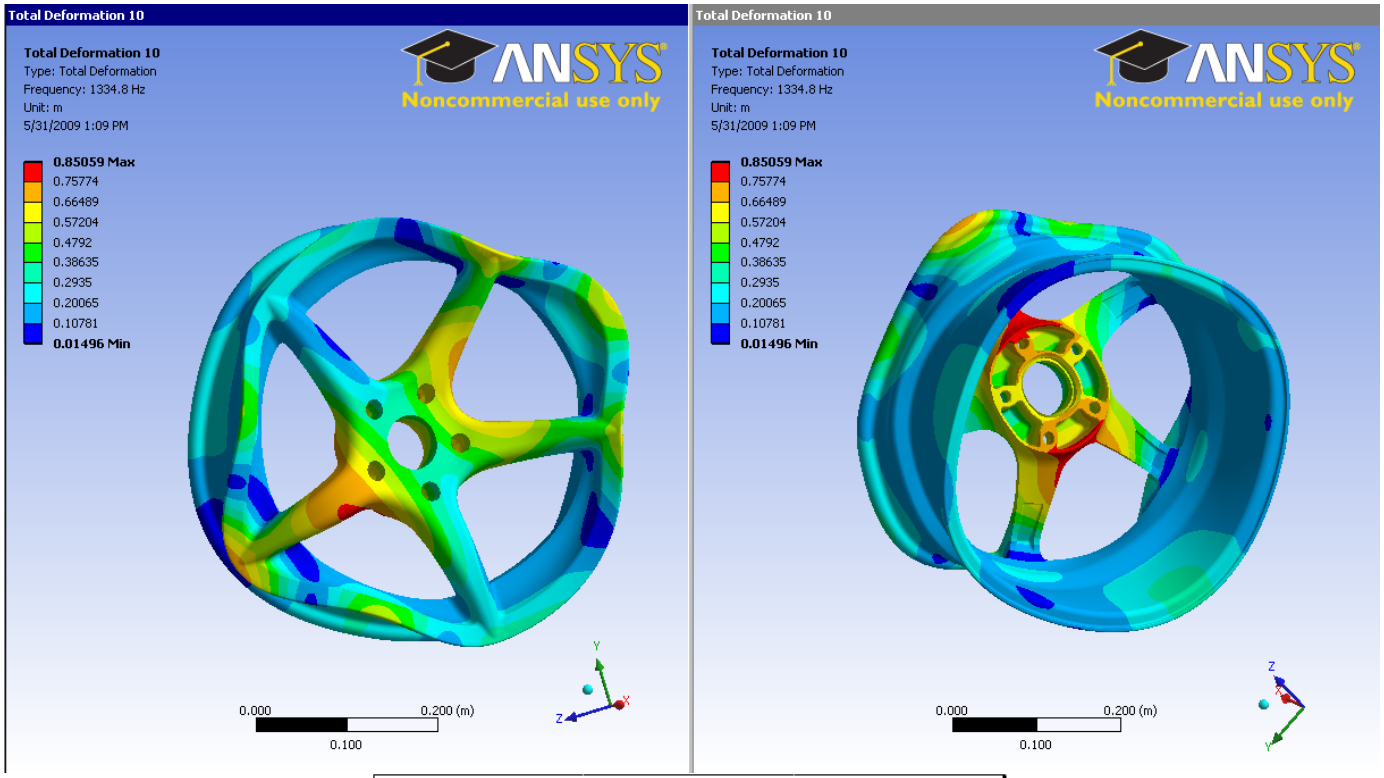
Tenth Mode



Frequency (Hz)		
Mesh 1 (61081 elements)	Mesh 2 (27527 elements)	Mesh 2 (21030 elements)
1334.8	1348.7	1410.1

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Discussions

Future Action:

- Analysis At Higher Speed Should Be Studied (For Example, 200 MPH Or Higher)
- Bearing Load Should Be Considered
- Thermal Stress Should Be Considered
- Acceleration Should Be Considered
- Finer Mesh Should Be Used For More Accurate Results
- Different Material Should Be Explored
- Analyze And Compare Between Different Designs