Finite Element Modeling and Analysis of NASCAR Frame

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ME 450 COMPUTER-AIDED ENGINEERING ANALYSIS
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Objectives

- Build Model of NASCAR Chassis in Ansys
- Static Analysis of NASCAR Chassis with Head on Impact
- Transient Analysis of NASCAR Chassis During Curve

Introduction

- National Association for Stock Car Auto Racing was Created February 21, 1948

Introduction Continued

- With the use of computer aided analysis NASCAR Teams Can Save:

  - Time
  - Money
  - Lives

Related Works

- Effects of Angles and Offsets in Crash Simulations of Automobiles with Light Trucks
- Design of a Winston Cup Chassis for Torsional Stiffness

Equations

- $F = ma$
- $a = V^2/?$
- $F = aV^2$

Background

- Why does NASCAR have rules?

  - Ensure Fair Competition

  - Driver Safety

Background

- NASCAR Chassis Rules

  -A minimum weight of 3,400 lbs

  -Frame rails are 3 inches wide by 4 inches high with 1/8 inch wall thickness made of magnetic steel box tubing

  -Frame rails minimum length of 65 inches, must be parallel with minimum distance between of 50 inches

NASCAR Chassis Rules Continued

- 110 inch wheel base, minimum roof height of 51 inches
- Firewall is 22-gauge steel
- The rear subframe must maintain a minimum width of 37 inches at fuel cell mounting location
- Frame rails must be minimum of 29 inches at steering box and not exceed inside width of 34 inches at the engine block

Model Details

- Approximately 114 Keypoints
- 169 Lines Connect the Keypoints

Model Details

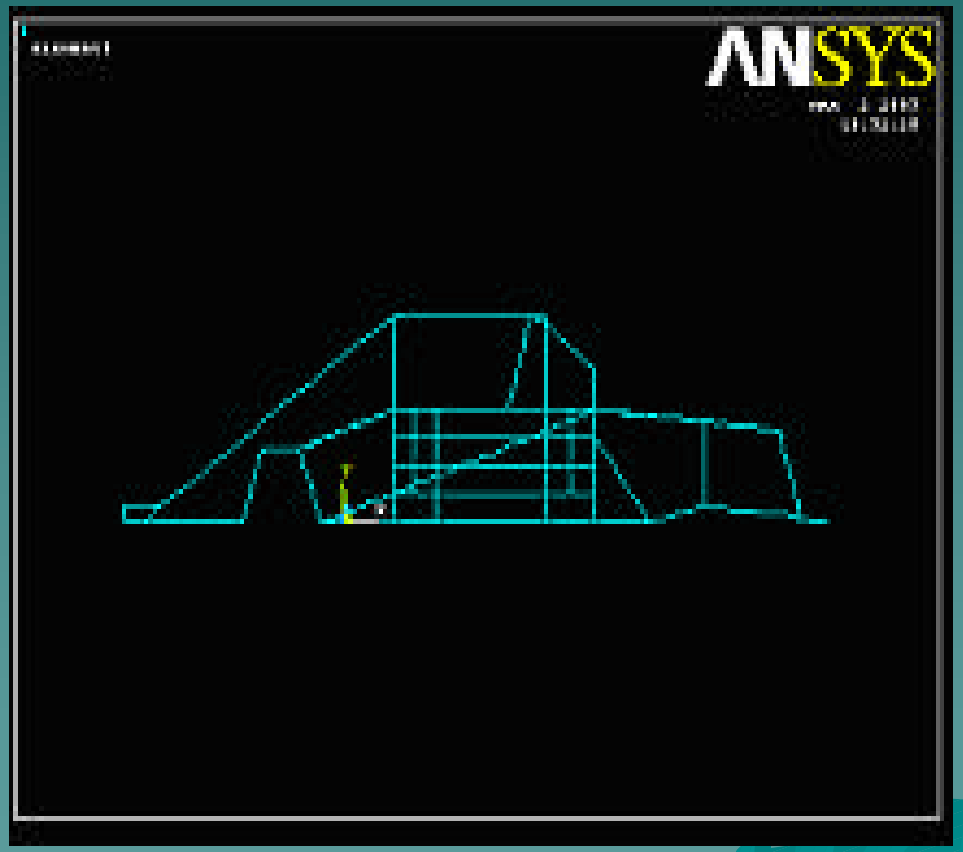
- Two Element Types Used

1. BEAM4
   - 3-D Elastic Beam

2. PIPE16
   - Straight Pipe

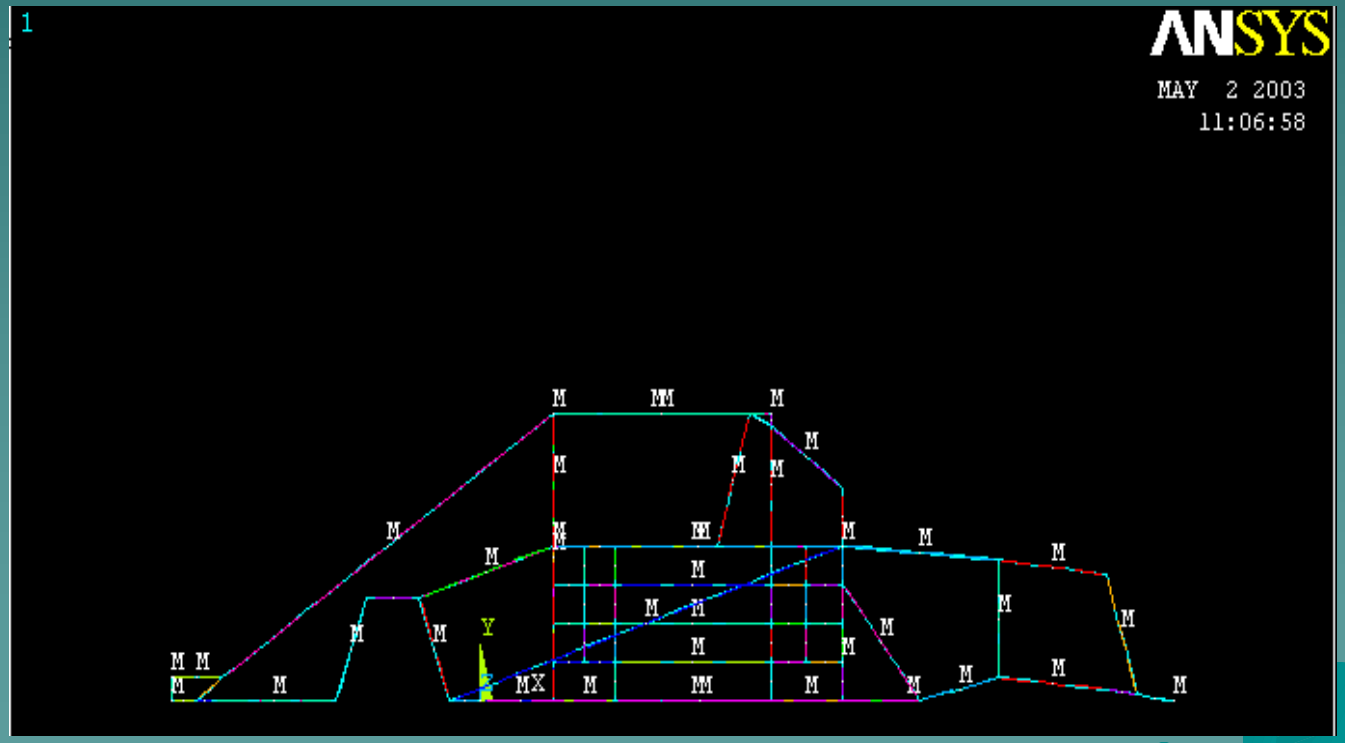
Model Details

- After Entering All Keypoints
- Connect All Keypoints with Lines



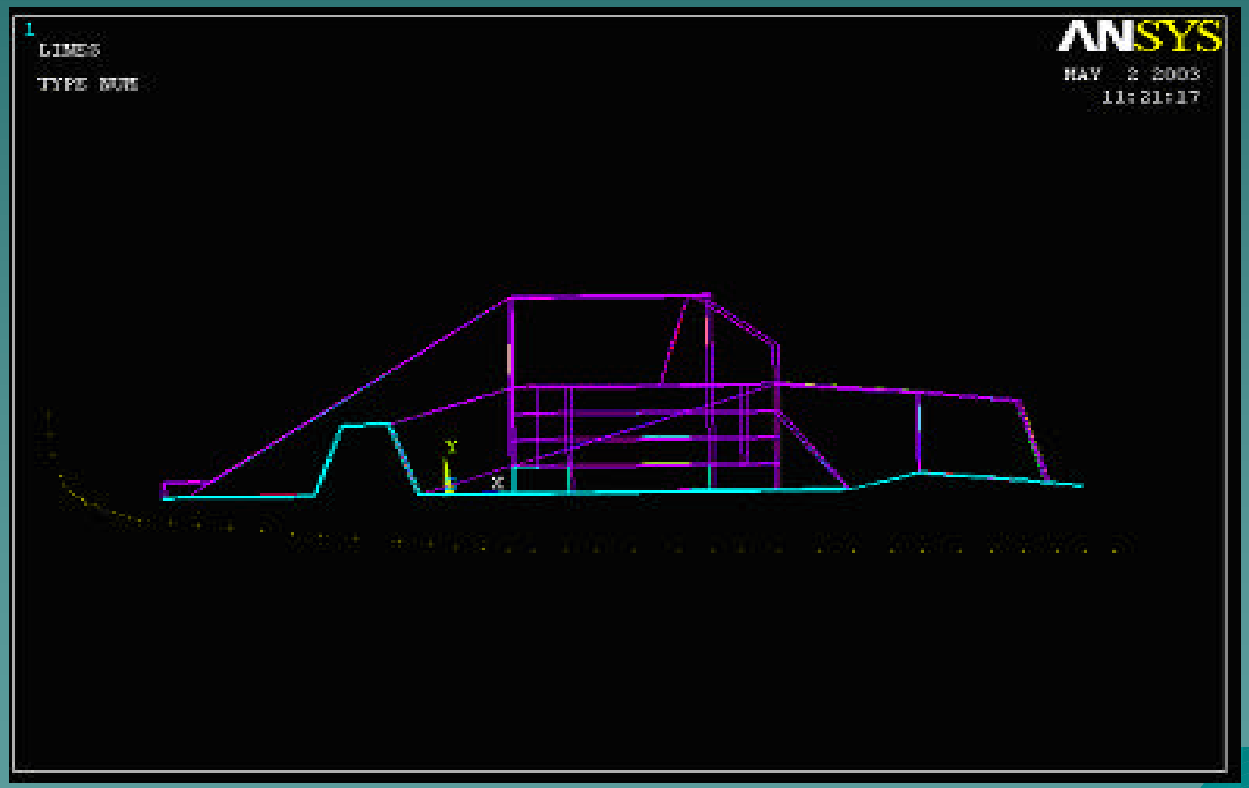
Model Details

- Enter the element edge length



Model Details

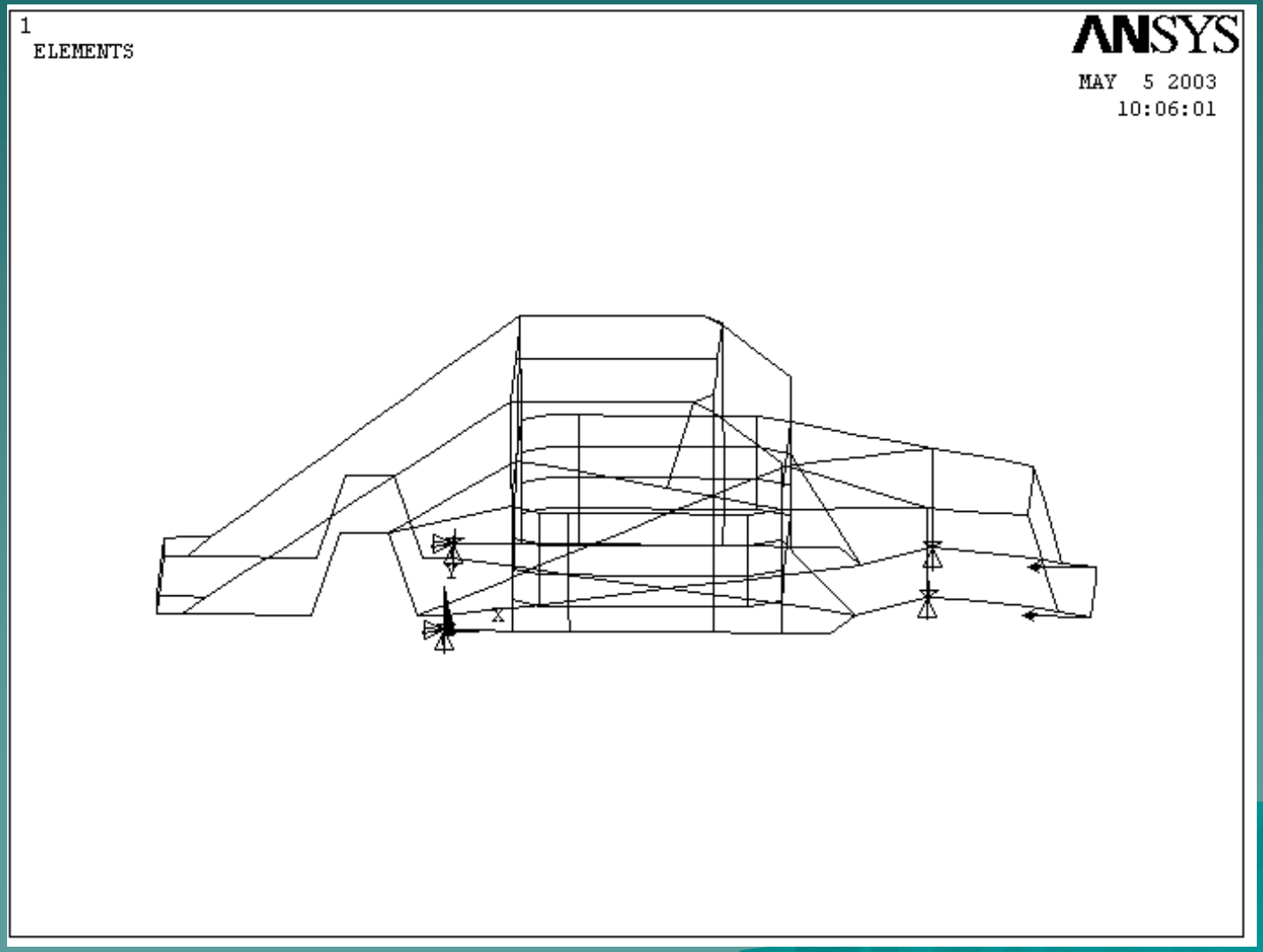
- Mesh Model



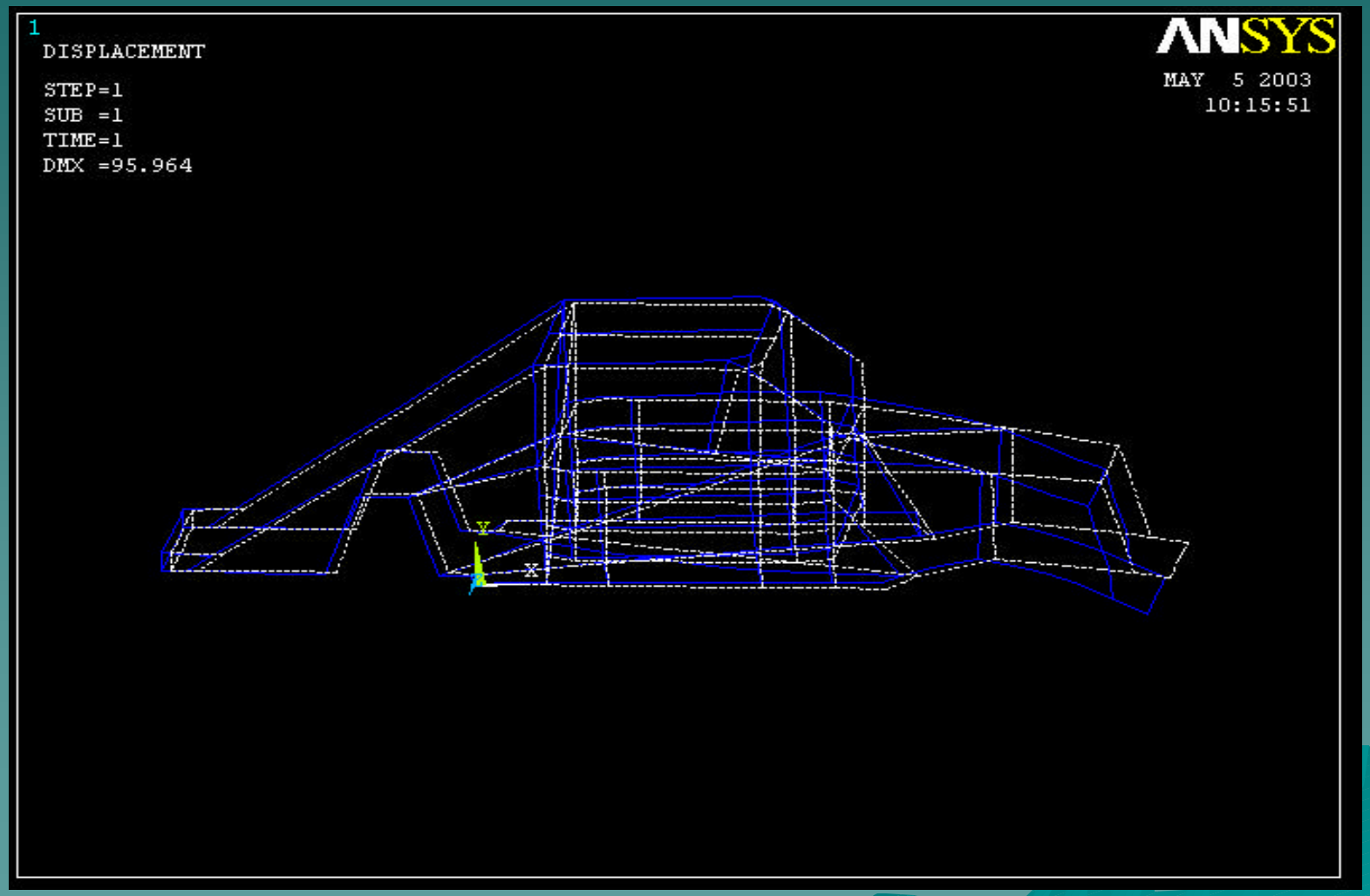
Model Details

- At keypoints 1 and 22 the chassis is constrained in the X, Y, and Z directions.
- At keypoints 7 and 16 the chassis is constrained in the Y and Z directions

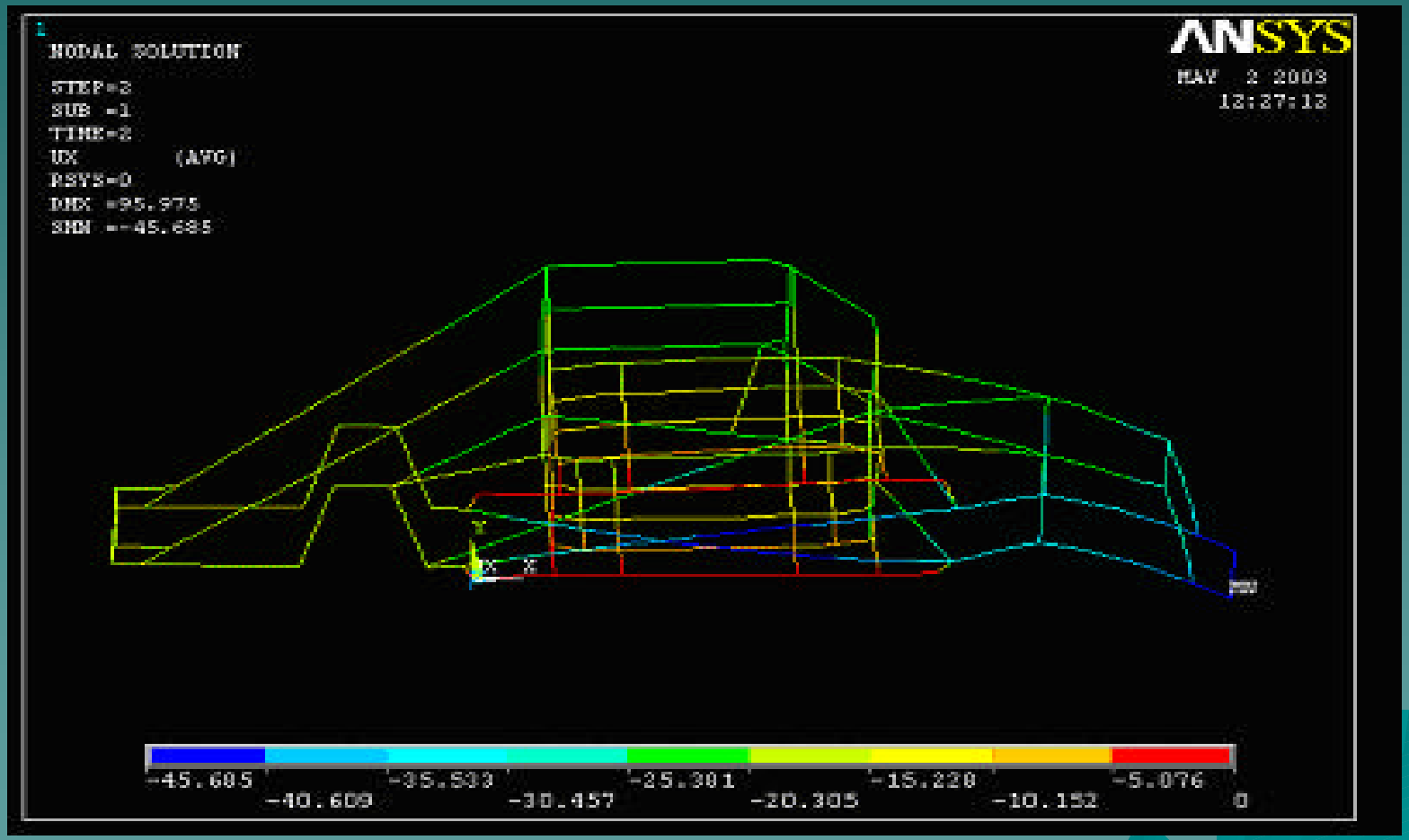
Boundary Conditions



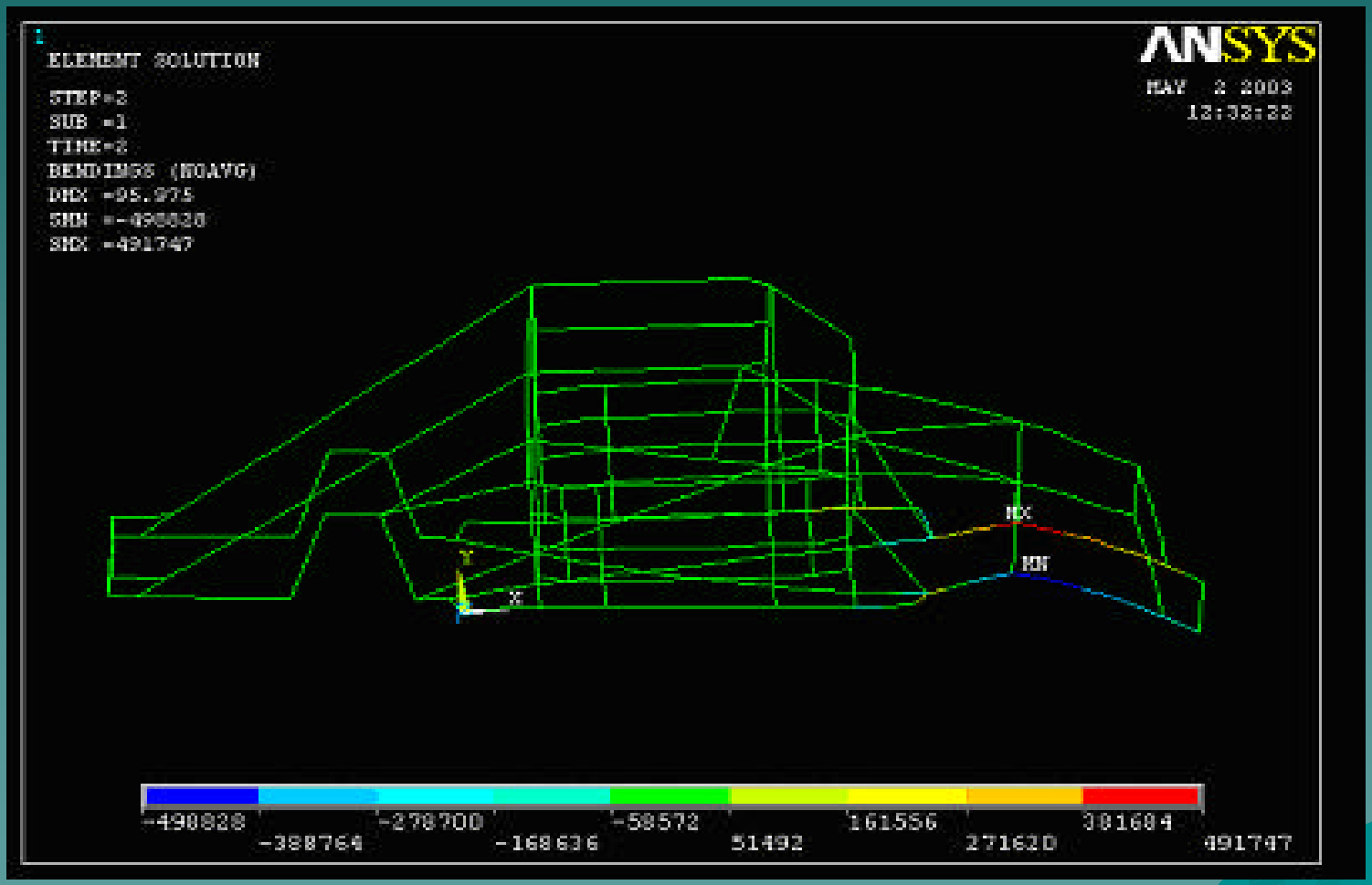
Static Analysis



Static Analysis



Bending Stress

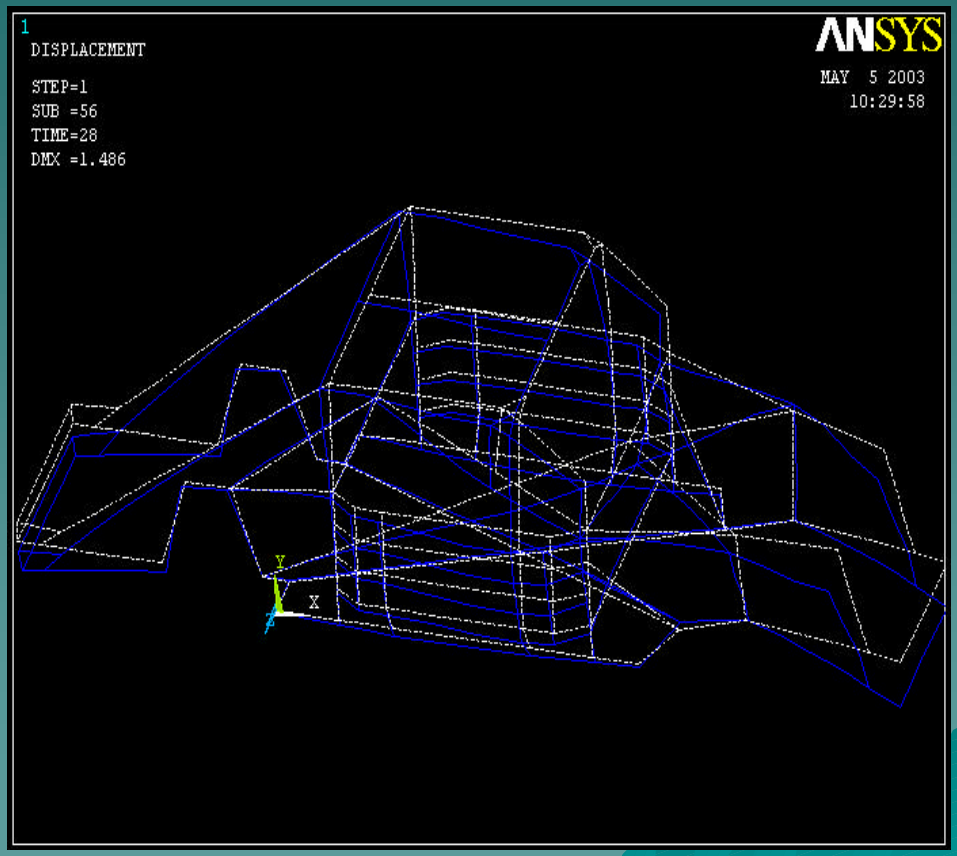


Von Mises


ELEMENT SOLUTION
STEP=2
SUB =1
TIME=2
VONMISES (NOAVG)
DMX =95.975
SMX =.715E+07
ANSYS
MAY 2 2003
12:31:35
MX
MN
Y
X
0
.794528
.159E+07
.238E+07
.318E+07
.397E+07
.477E+07
.556E+07
.636E+07
.715E+07

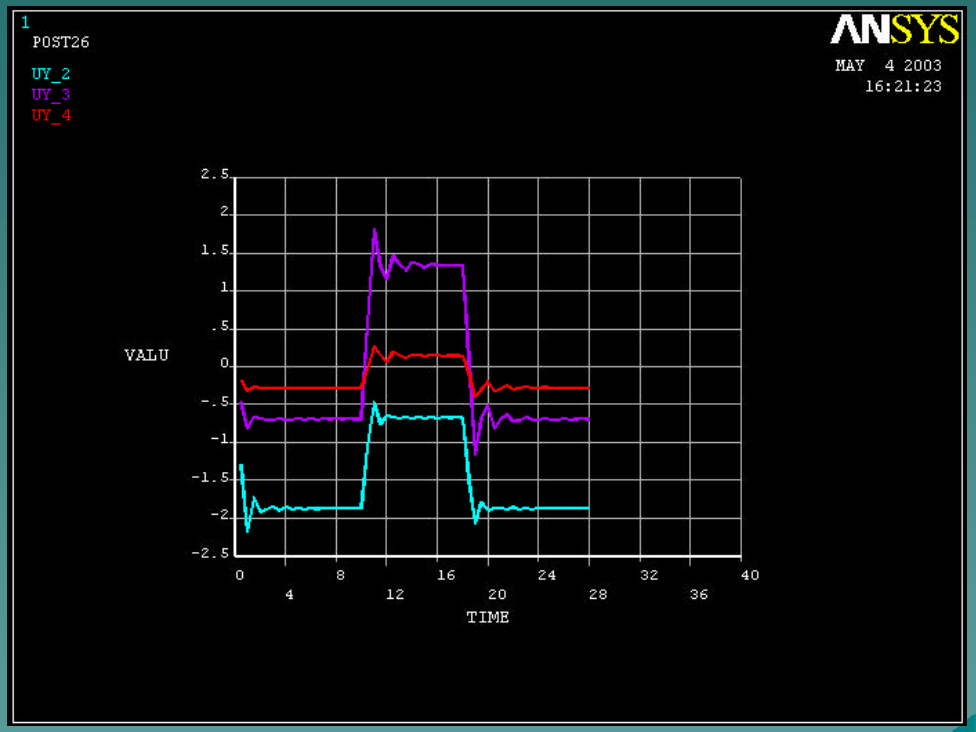
Dynamic Analysis

- Dynamic analysis is the modeling of continually changing forces on the frame as it goes from straightaway to curve.
- Using the equations mentioned before, we calculated the forces acting on the chassis before and in a curve.
- The Forces were in the negative y-direction (downforce) and in the positive z-direction (normal acceleration).



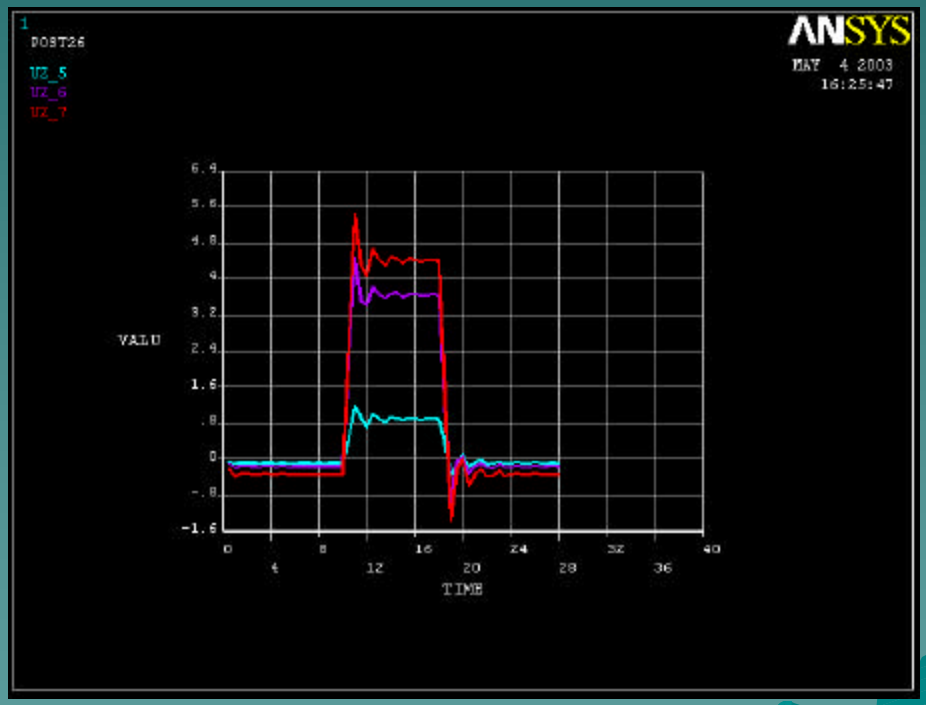
Dynamic Analysis

- The graph shows the y-displacement with respect to time during the transient analysis.
- It is easy to see the effects of damping in this plot.



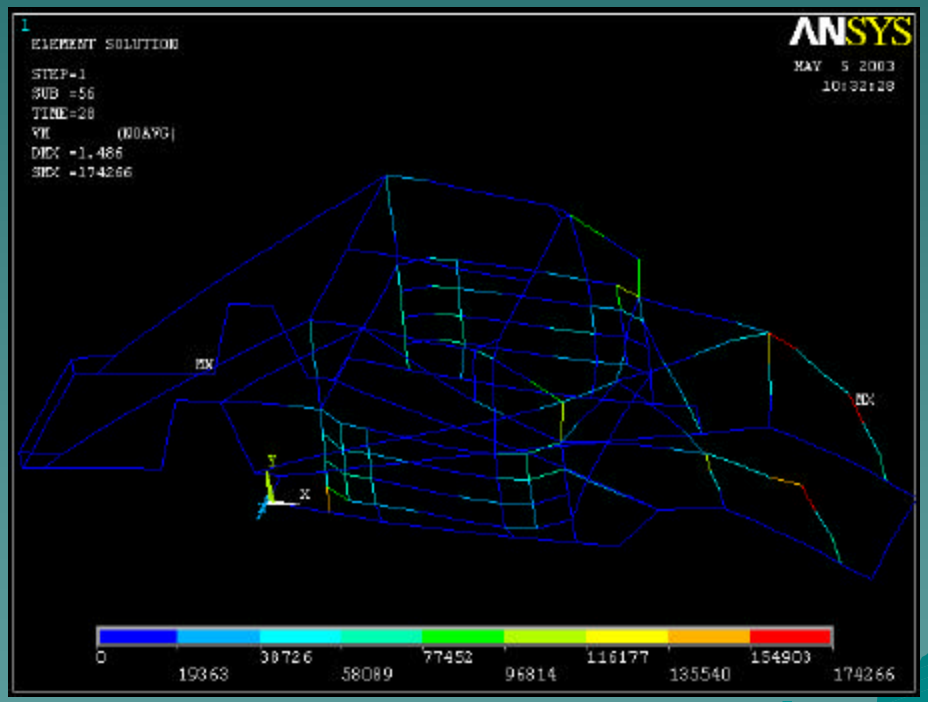
Dynamic Analysis

- The graph shows z-displacement and is very similar to the y-displacement graph.
- Much like the y-displacement, it is easy to see the effects damping has on the transient response.



Von Mises Stress

- The contour plot of the Von Mises stresses is shown below.
- The maximum Von Mises stress was calculated to be 174266 lb/in^2.
- The maximum stress was located at the point where the y and z forces meet at the same node.



Conclusions

- The current design of the NASCAR chassis is very dependable during a race and in crash situations
- The only problem is the extra bending happening at the front of the frame.

Impact Statement

- Finite Element Analysis of NASCAR chassis' can be used to improve driver safety during a race.

Bibliography

- Burt, William. Stock Car Race Shop: Design and Construction of a NASCAR Stock Car. MBI Publishing, 2001. Osceola, WI.
- **SAE TECHNICAL PAPER SERIES: 983053**

  Design of a Winston Cup Chassis

  for Torsional Stiffness

  Lonny L. Thompson, Srikanth Raju and E.Harry Law

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