Front Suspension Modeling using an Integrated FEM - Multi body approach

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Maruti Suzuki India Limited

Maruti Suzuki India Ltd.

- Complete Car maker
  from people's car M800 to luxury sports sedan Kizashi , there's a car for everyone

- Subsidiary of Suzuki Motor Corporation Japan
- 45% market share in India
- Sold over 10 million Vehicles , only Car manufacturing company from India to join 10 million club
- Rated 1st in Customer Satisfaction Index as per JD Power survey for 11 years in a row

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Introduction

Mathematical model of an automobile is very crucial for

- Prediction of durability performance at the early stage of design
- Increasing product reliability
- Reduction of weight
- Reduction of costs & product development time.

Objective: To predict the durability performance of the vehicle using FEM/Multi Body approach

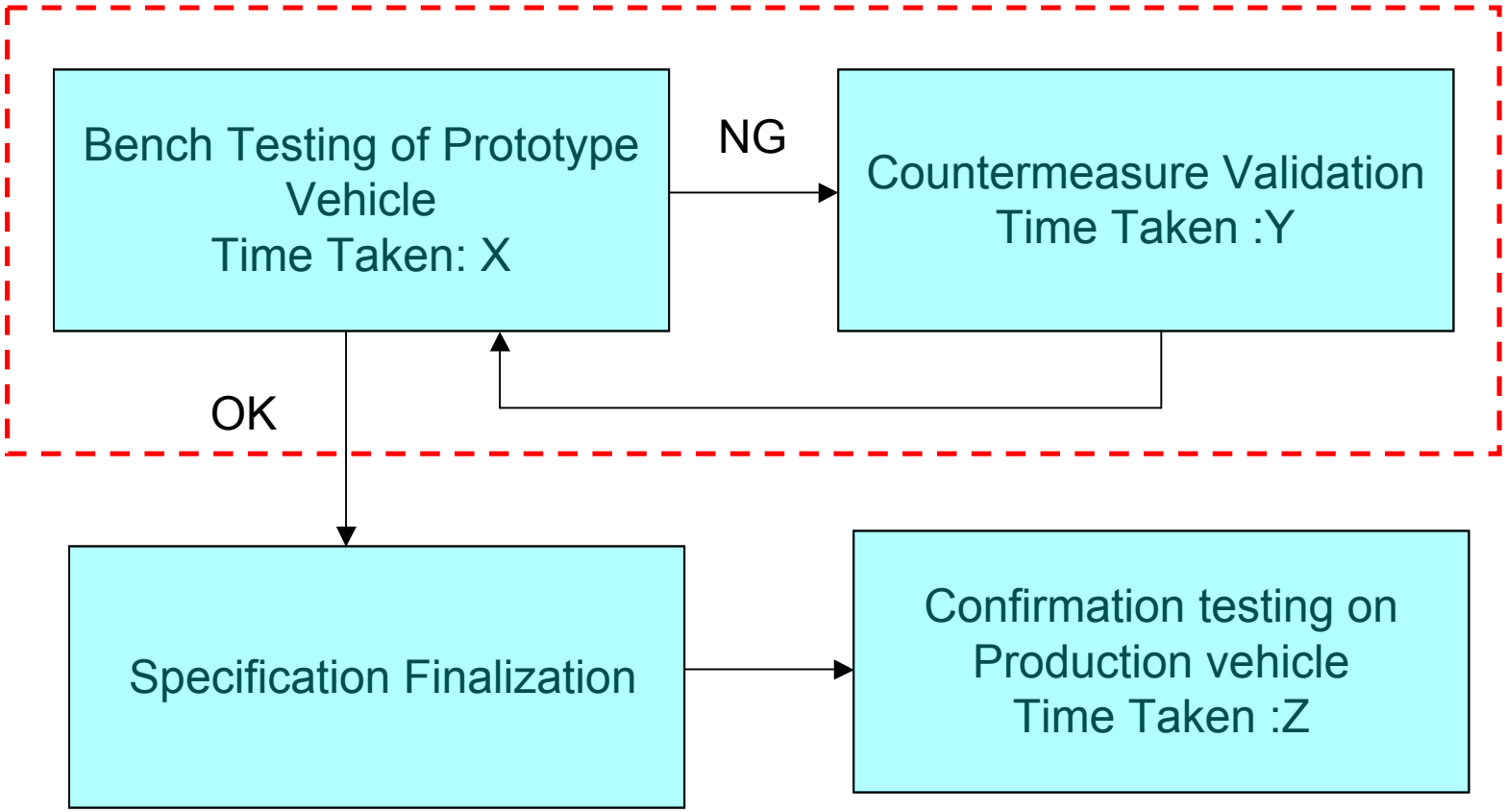
Targets for Indian Market

- Durability requirements are high.
- Product reliability expectations are high.
- Need for optimisation between smooth & rough roads
- Significantly high Suspension forces due to

  a) More than 2 Pax loading conditions

  b) High approach speeds over rough roads

Current Methodology

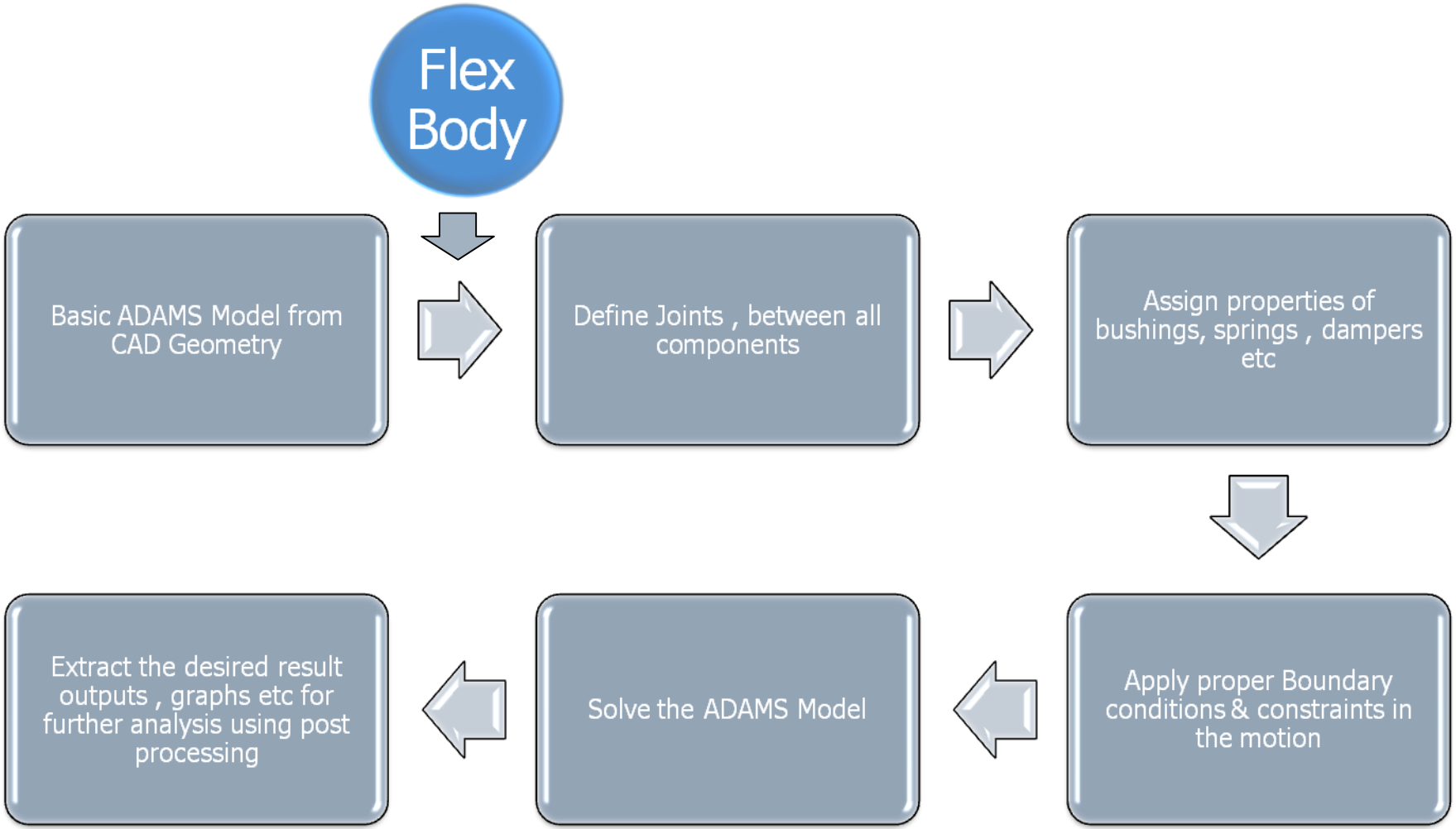


Total Time required = X +Y + n*(X+Y) +Z (n = no of iterations)

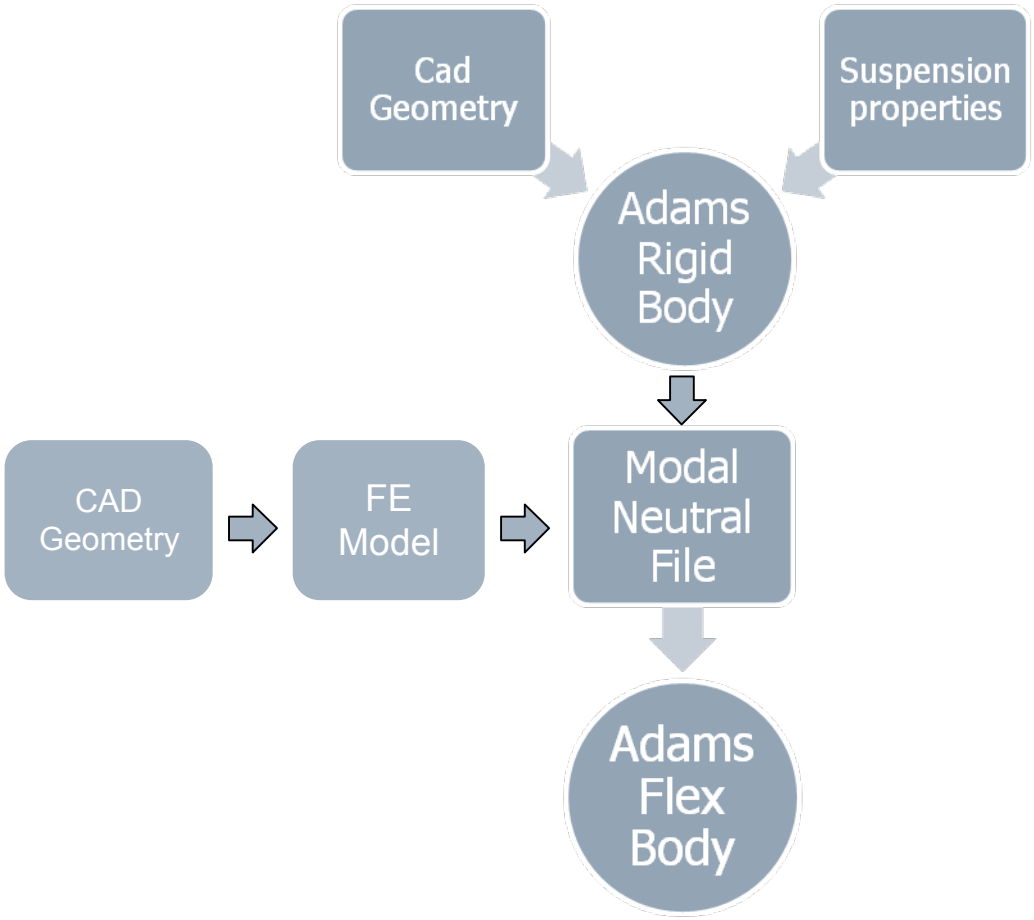
Need for FEM Multi-body Integrated Approach

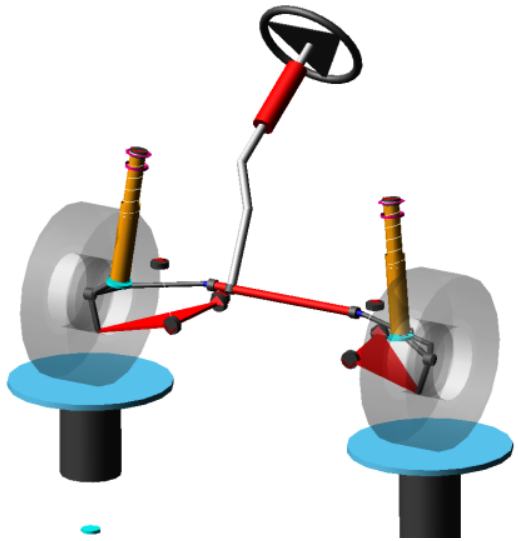
- To study impact of Suspension Forces on Vehicle Durability.
- To study impact of change in Suspension stroke.
- Virtual simulation to predict vehicle durability at an initial phase of product development which provides insight to chassis / body design group for achieving design target performance

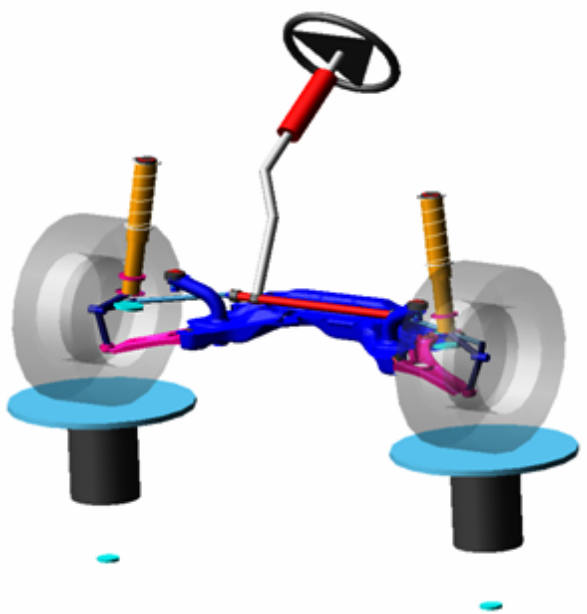
Suspension Modeling



Flex Body Modeling



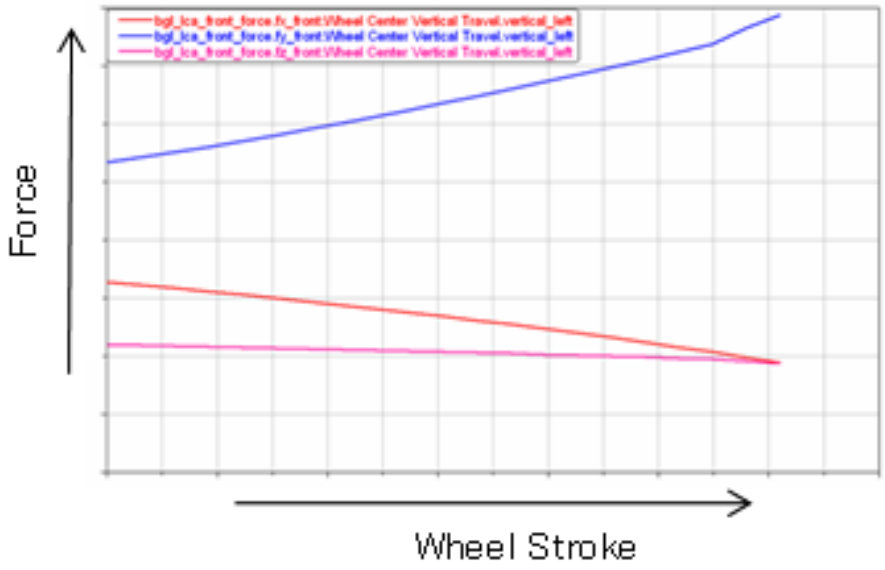




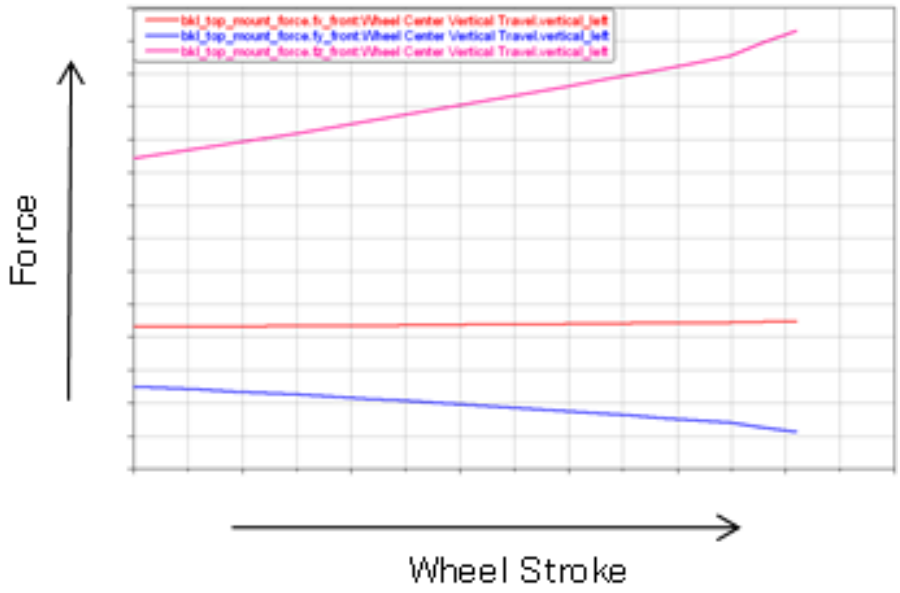
Simulation Results

- Performing Vertical bench test (Impact Loading) on the MBD model.
- Performing Vertical bench test (General durability) on the MBD model.
- Forces extraction at body connection points at both Test conditions.

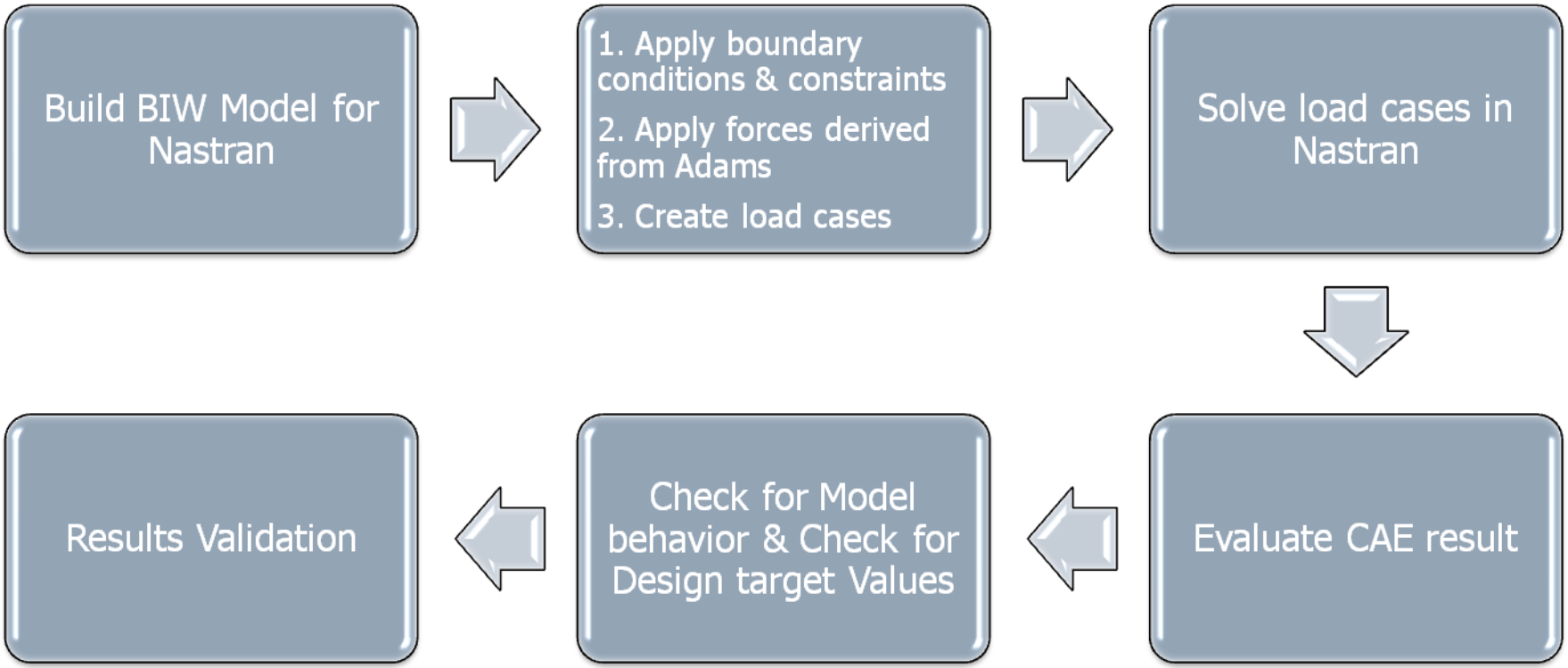
Suspension Forces at Bush Front , Suspension Arm



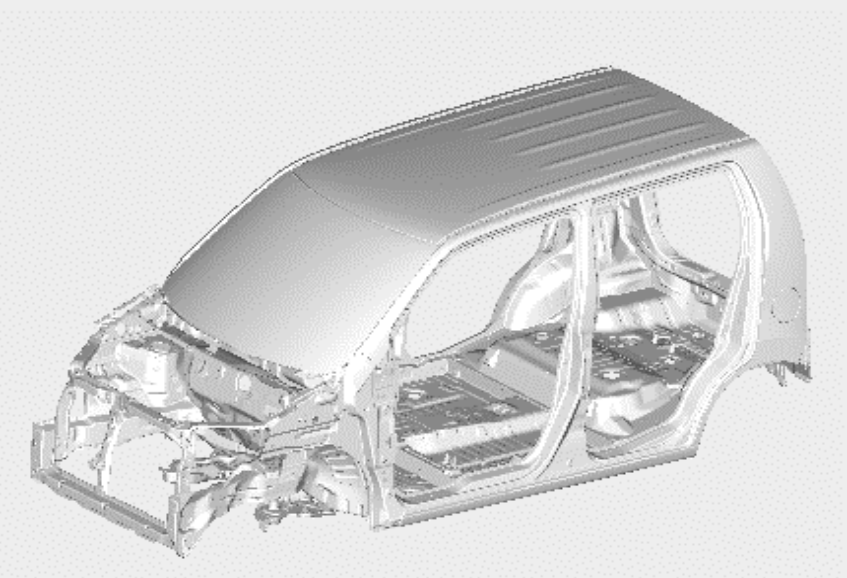
Front Suspension Force at Top Mount



CAE Simulation

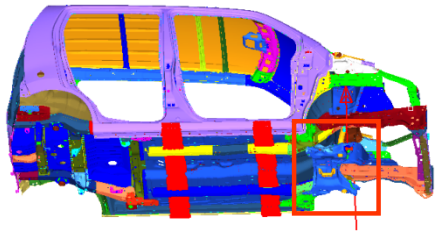


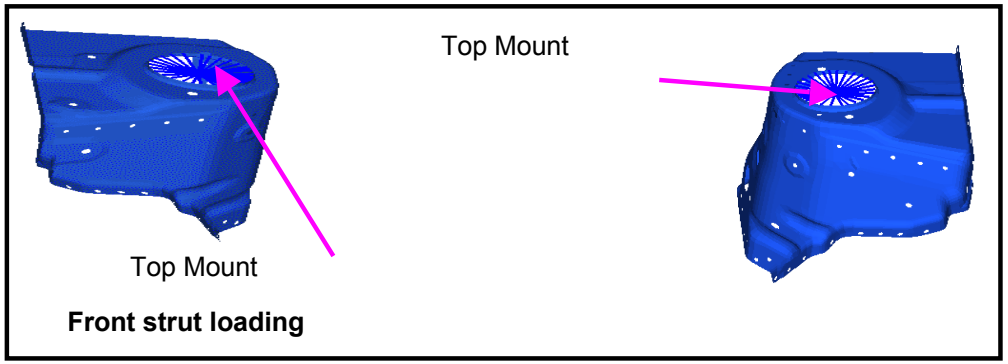
FE Modeling

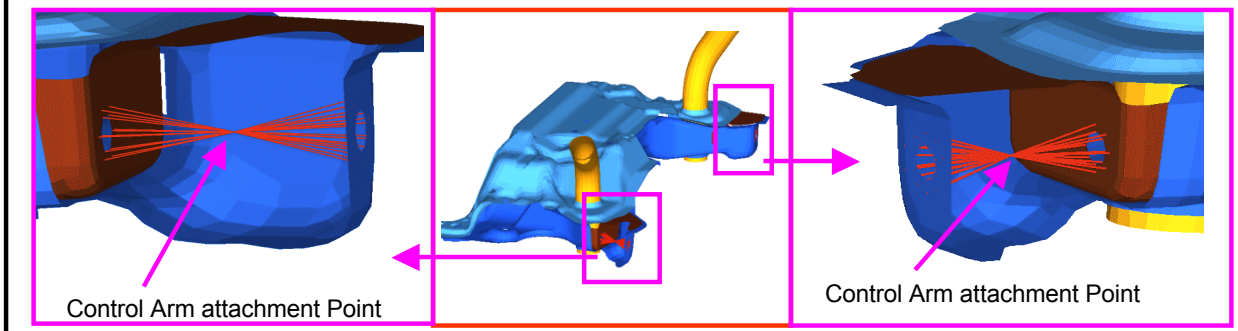


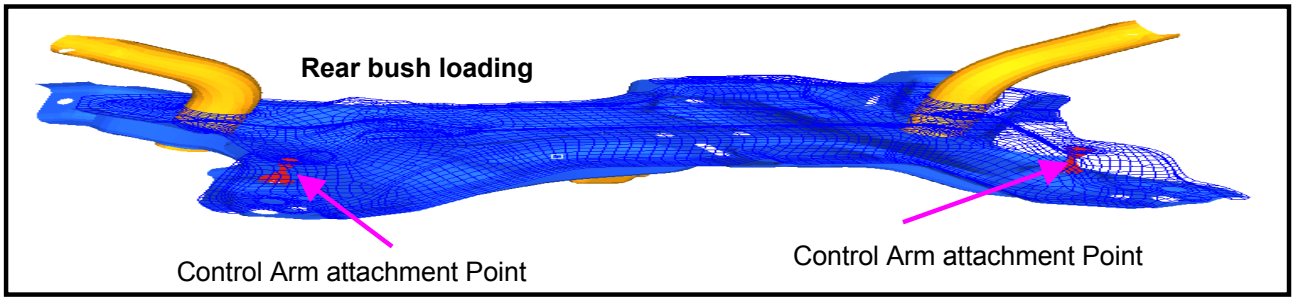
- FE model preparation with boundary conditions.
- Model is evaluated for both loading conditions.
- Following analysis were performed
  a) Static durability for both Impact & General Durability requirements
  b) Transient response

FE Modeling



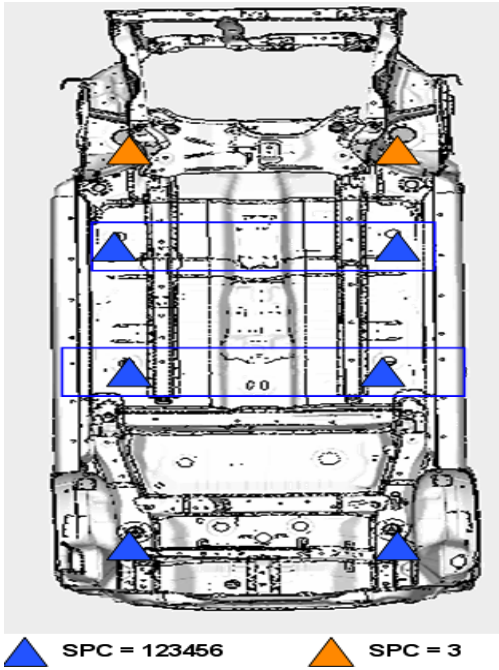




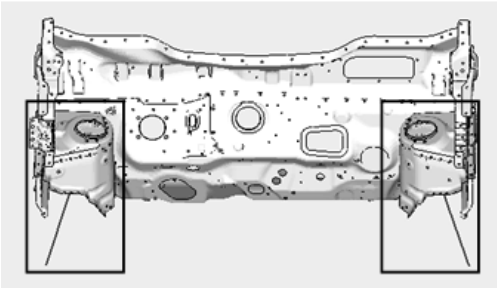


Note: Force calculated is resultant of ADAMS Data

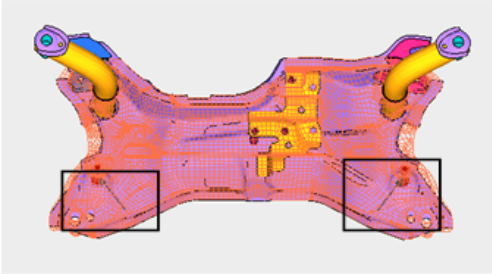
Loading & Boundary Conditions



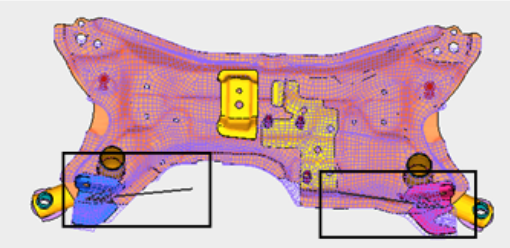
View of the vehicle with constraints



Force applied at Strut location

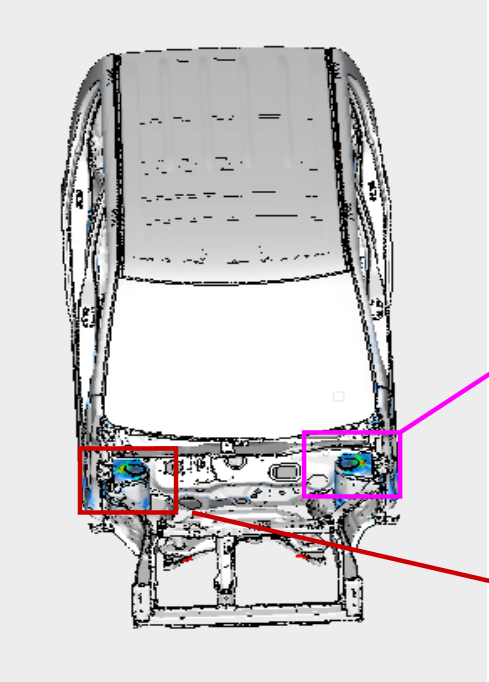


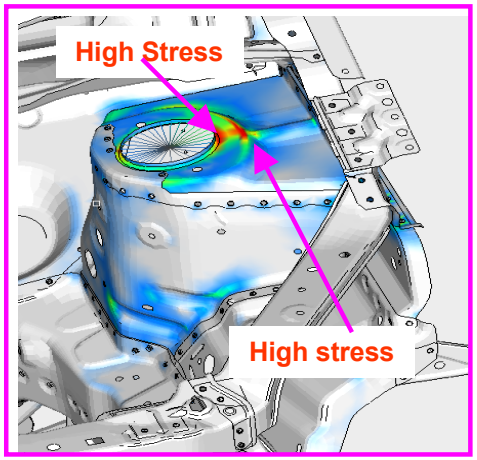
Resultant Force applied at Front bush location

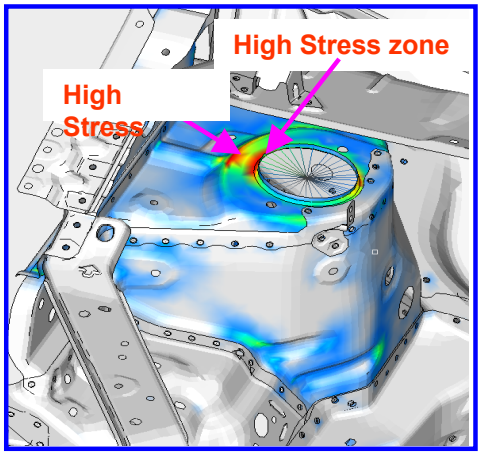


Resultant Force applied at rear bush locations

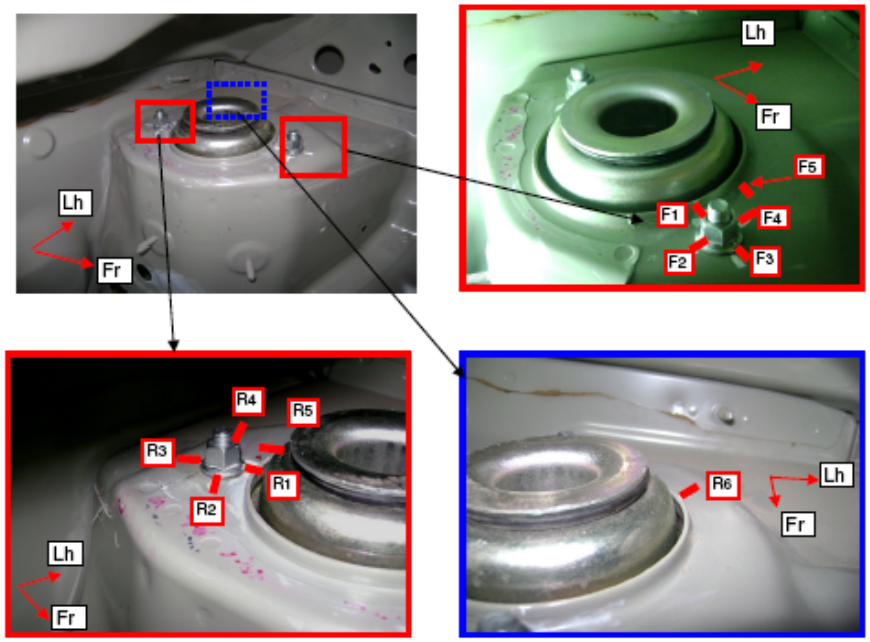
CAE Analysis Results





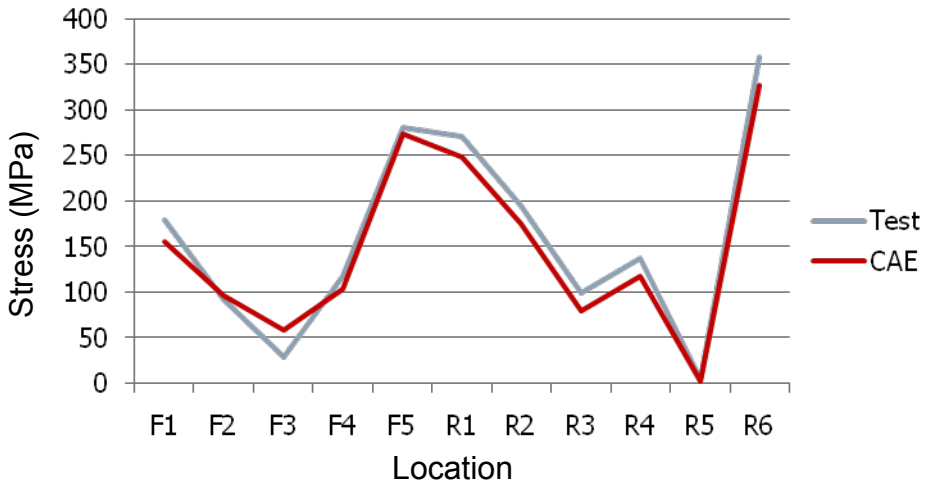


Results Validation



Strain gauge locations

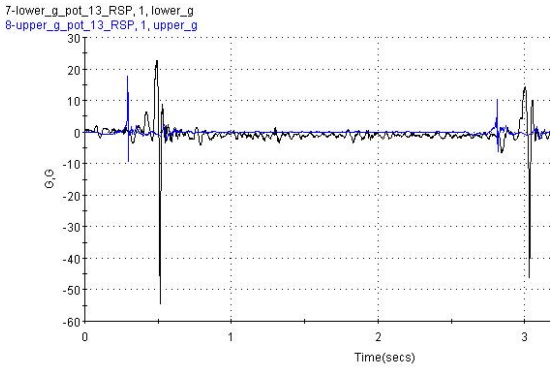
Testing v/s CAE Results

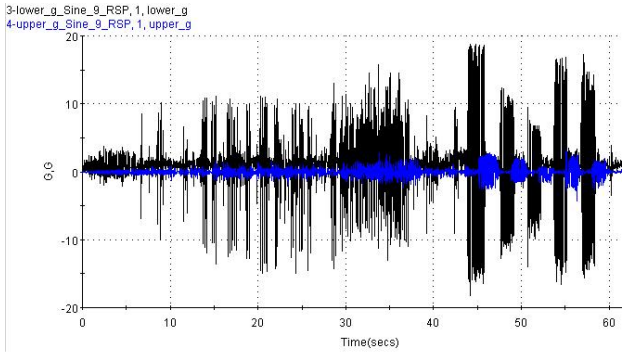


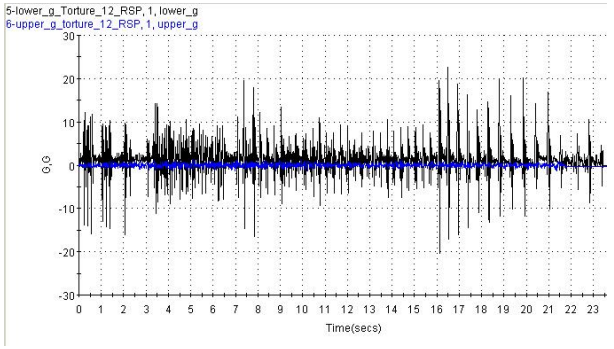
Good Correlation is achieved in CAE & testing Results

Input Data Acquisition

Actual acceleration data are captured for the vehicle & these data were used as input for CAE analysis.

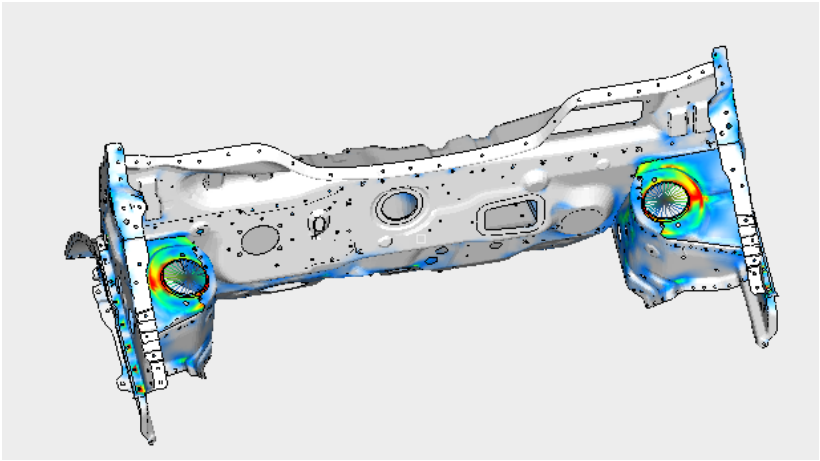




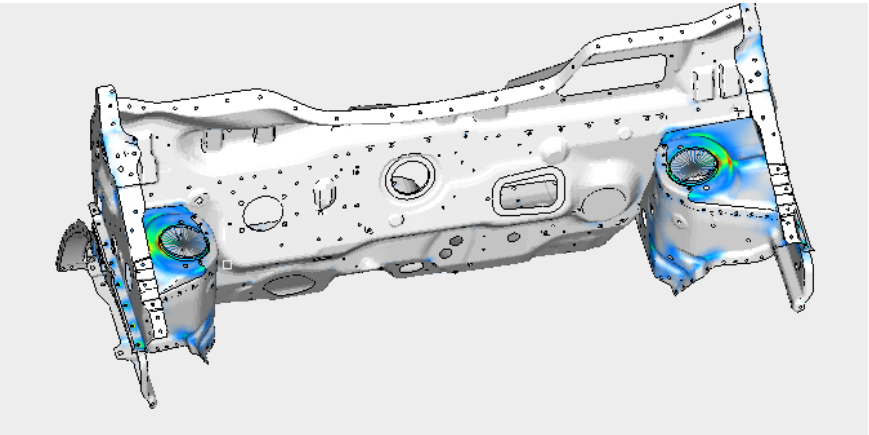


Transient analysis was done to confirm stress pattern with respect to linear static analysis

Analysis Re-validation



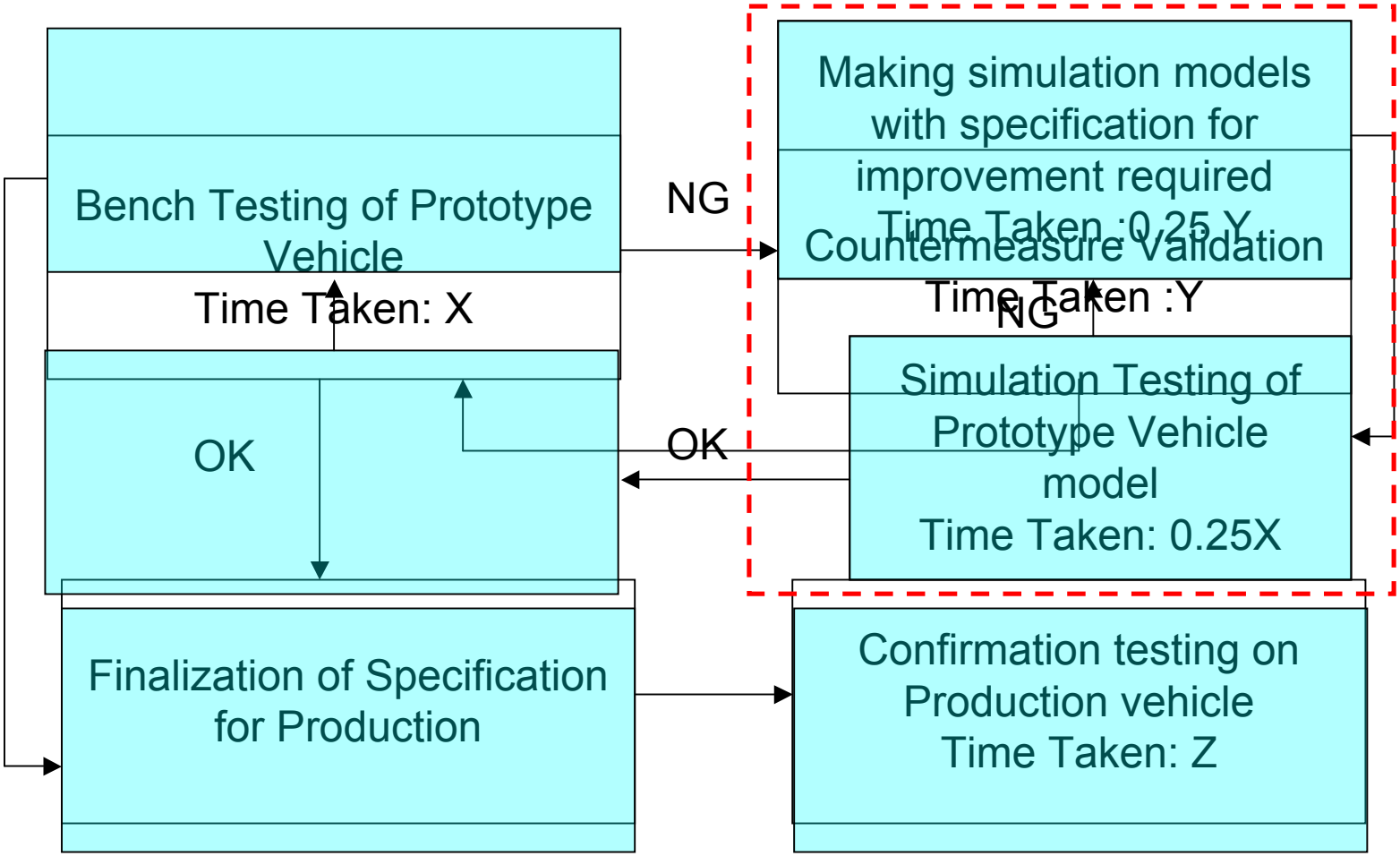
Impact Loading Condition



General Durability Condition

- FE results shows strong correlation with actual parts stress measurement.

New Methodology



Total Time required = X + n*0.25(X+Y) +Y +Z (n = no of iterations)

Conclusion

- Methodology was established to calculate suspension forces using ADAMS Flex Body approach.

- Analysis provides the first insight to real-world loading conditions of suspension / Body parts during early stage of design.

Future Scope

- Dynamic Loading Durability analysis:

  road profile as a input or a virtual four post shaker

- Analysis of Steering System

  Overall steering ratio, steering linearity, Ackerman etc.

- Full-Vehicle Design and Analysis

  Dynamic durability analysis to simulate vehicle behavior over 3D obstacles. Frequency response analysis

Thank You