Optimising the Handling Behaviour of a Vehicle with McPherson Front Suspension and Twist Beam Rear Suspension Using ADAMS/CAR

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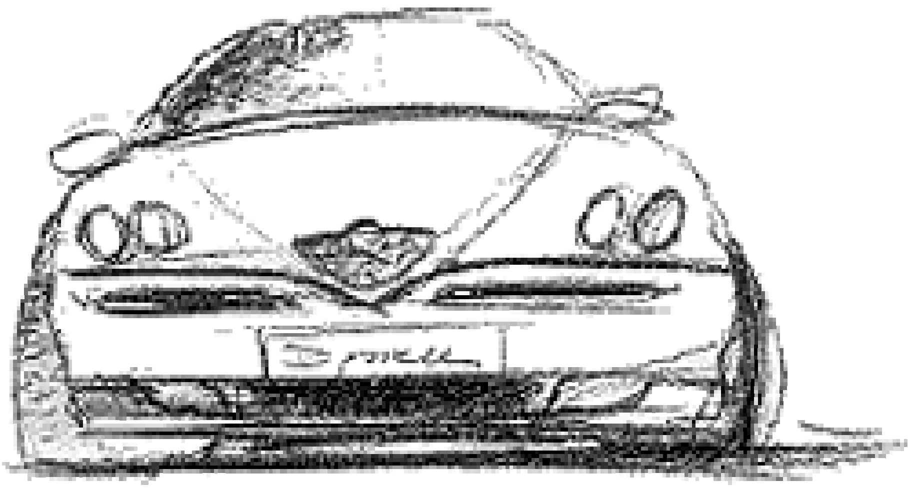
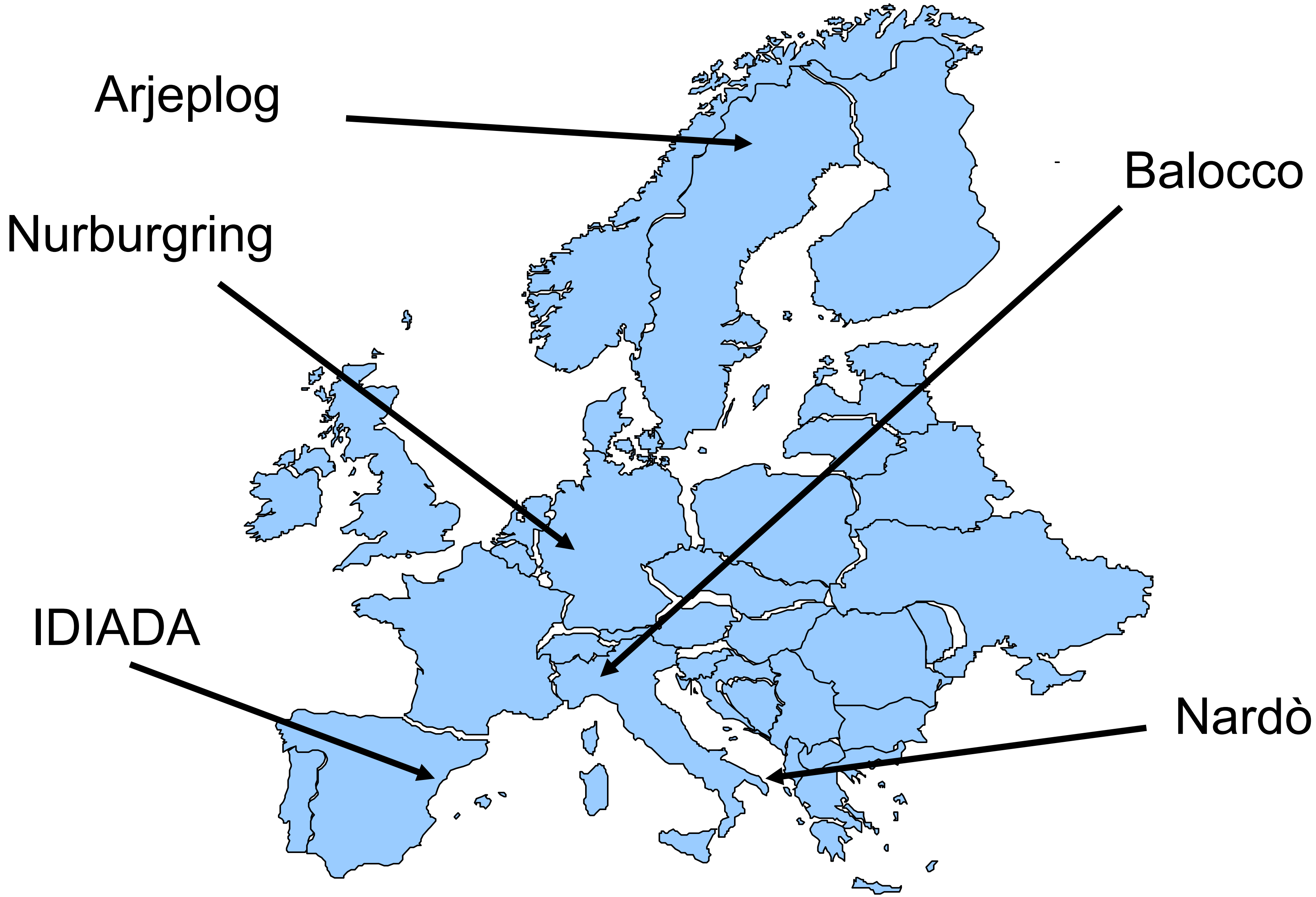
Matteo Lanzavecchia

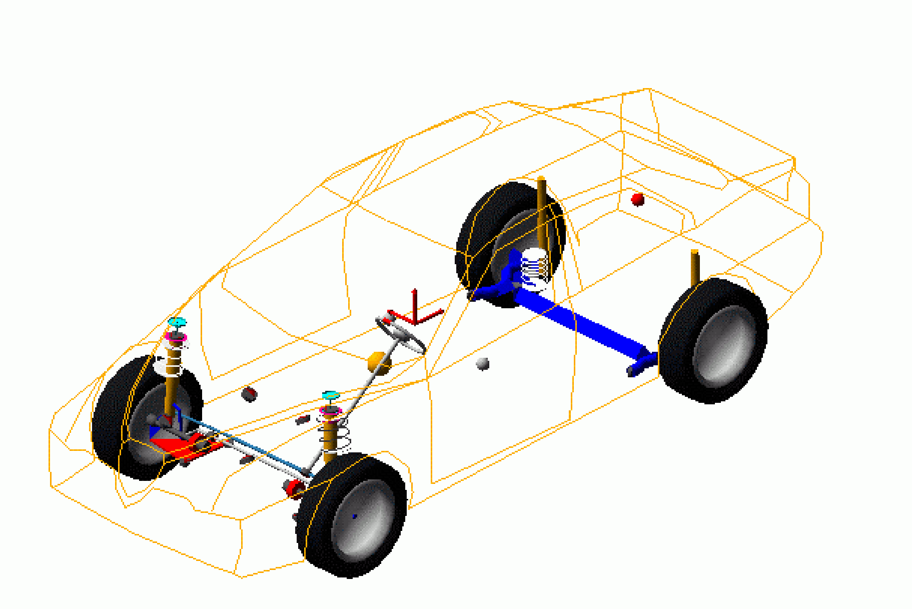


Alfa Romeo Vehicle Dynamics Department



New Car Development

- **Suspension layout**:
  - McPherson Front Suspension
  - Twist Beam Rear Suspension
- **Handling_Ride behaviour:**
  - ALFA Philosophy
  - Benchmarking



Virtual PROTOTYPE

New Car Development

- **Suspension Analysis**
  - Optimization of Characteristic Curves
    - Steering
    - Wheel Travel (Parallel and Opposite)
    - Longitudinal and Lateral Loads

- **Full Vehicle Analysis**
  - Steady state circular run
  - Steer wheel Step With Steering Wheel Release
  - Steer Frequency Response
  - Iso Lane Change (with ADAMS/Driver)
  - 3D Road Simulations

Twist Beam Rear Suspension

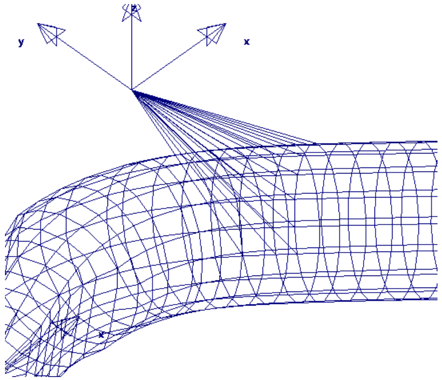
- **Use of FBG (Flexible Body Generator) in ADAMS/Car environment due to the following reasons:**
  - Faster
  - User Friendly
  - Suitable for Vehicle Dynamics Engineers

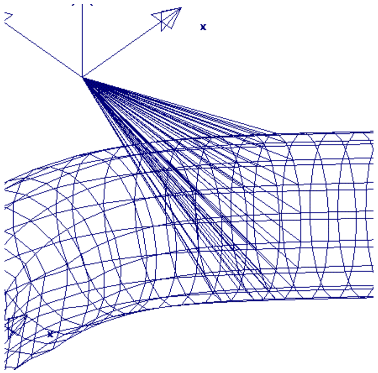
  Than any other FEM Programs

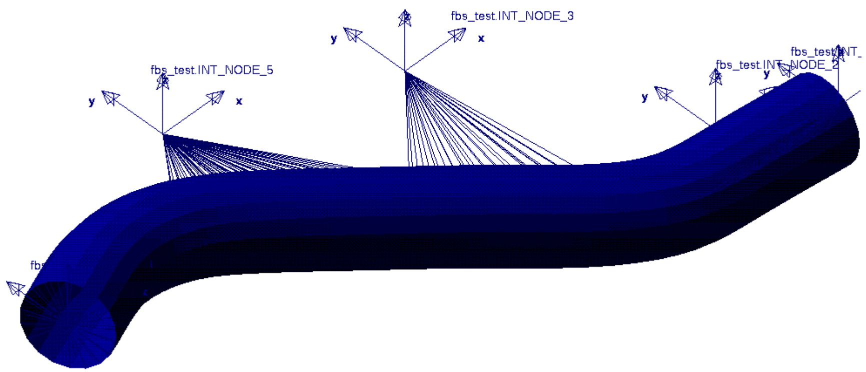
- **Previous Validation of the FBG-model on existing twist beams**
  - NASTRAN Mesh Simulations
  - Real prototype Bench-Tests

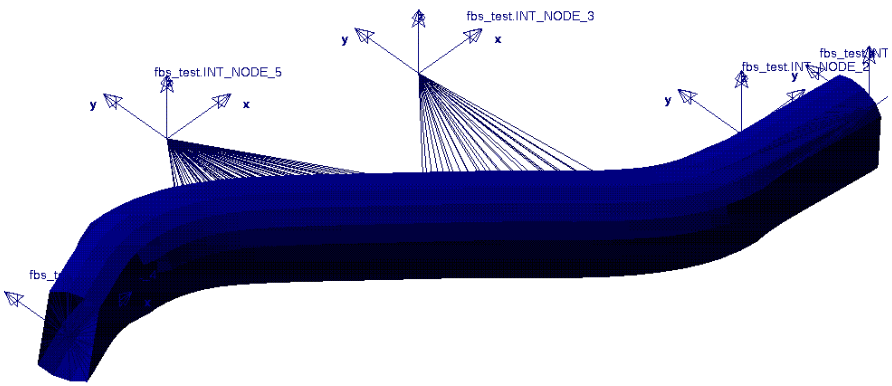
Flexible Body Generation

- **FBG Parameters Setup for twist beams**
  - Thickness
  - Cross Sections
  - Geometry
  - ......

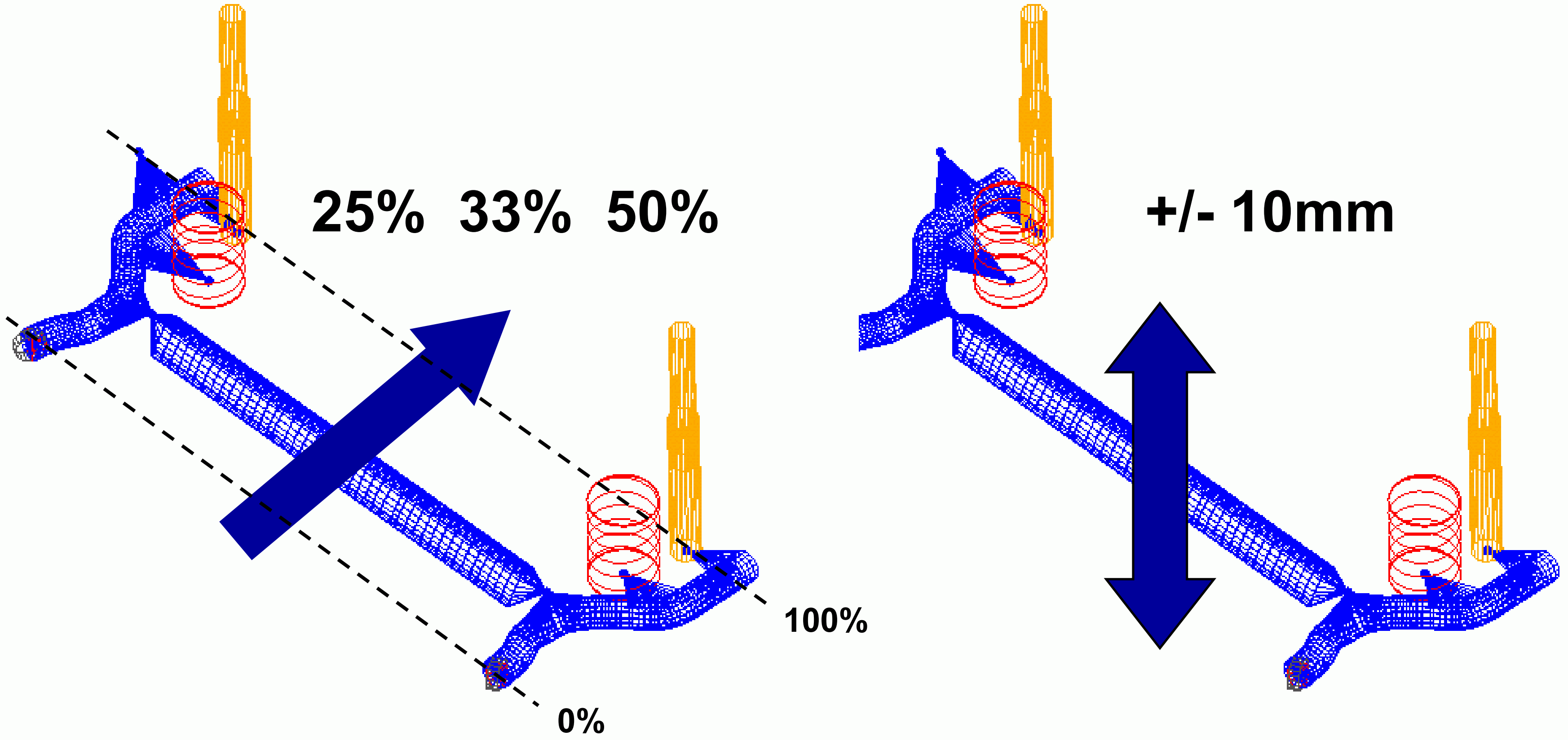






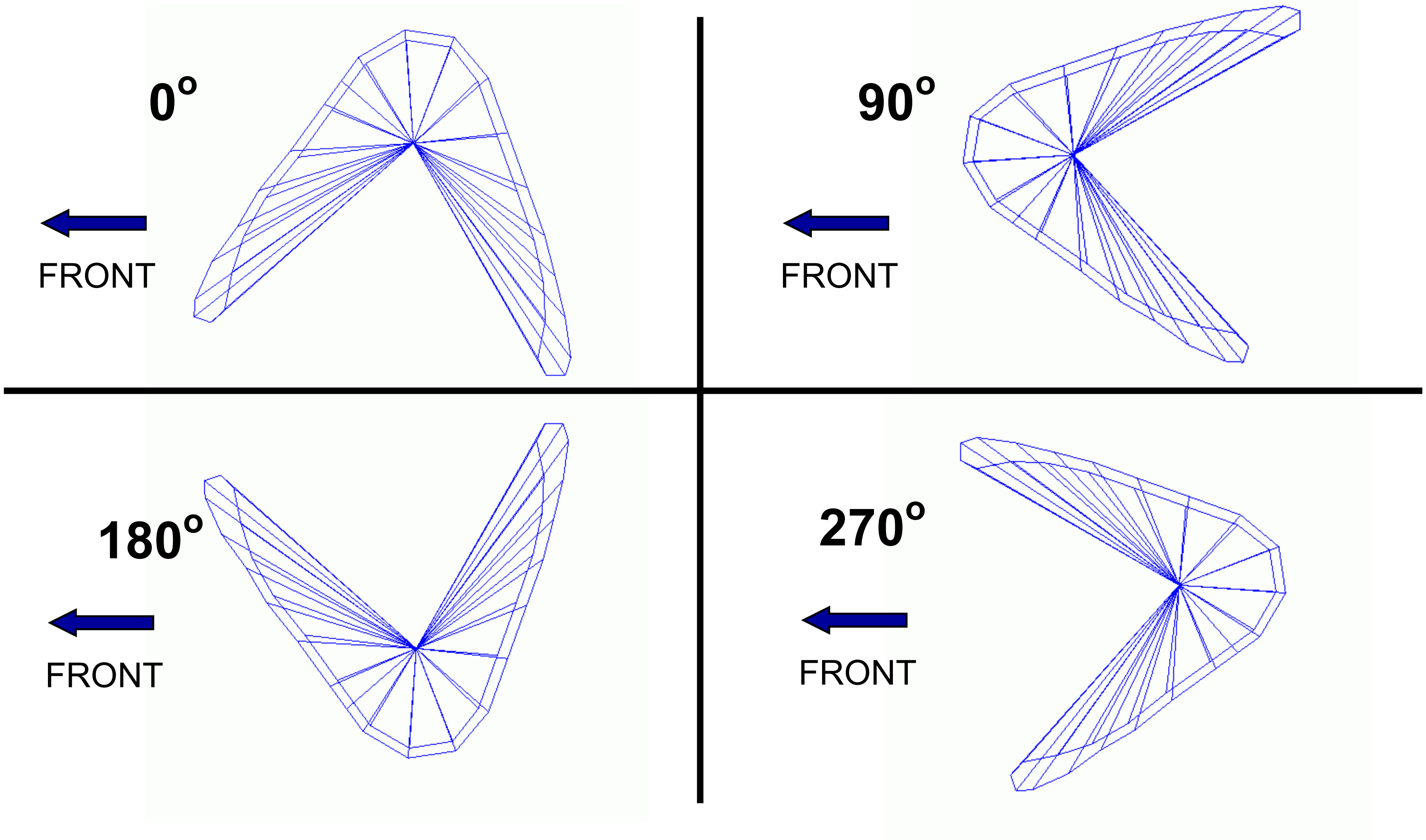


Twist Beam Suspension Analysis

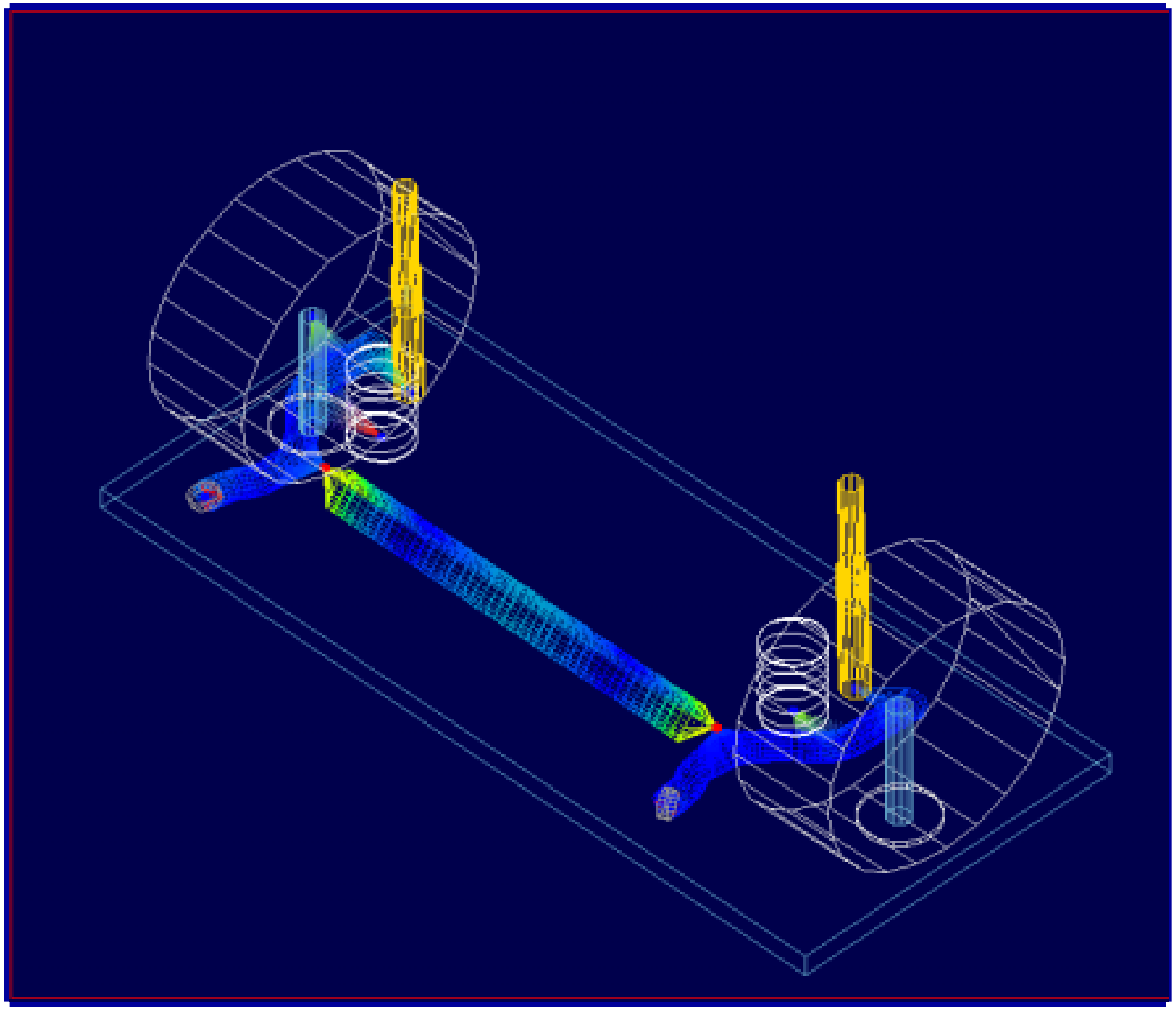


The percentage indicates the distance between the attach to body (0%) and the wheel center (100%)

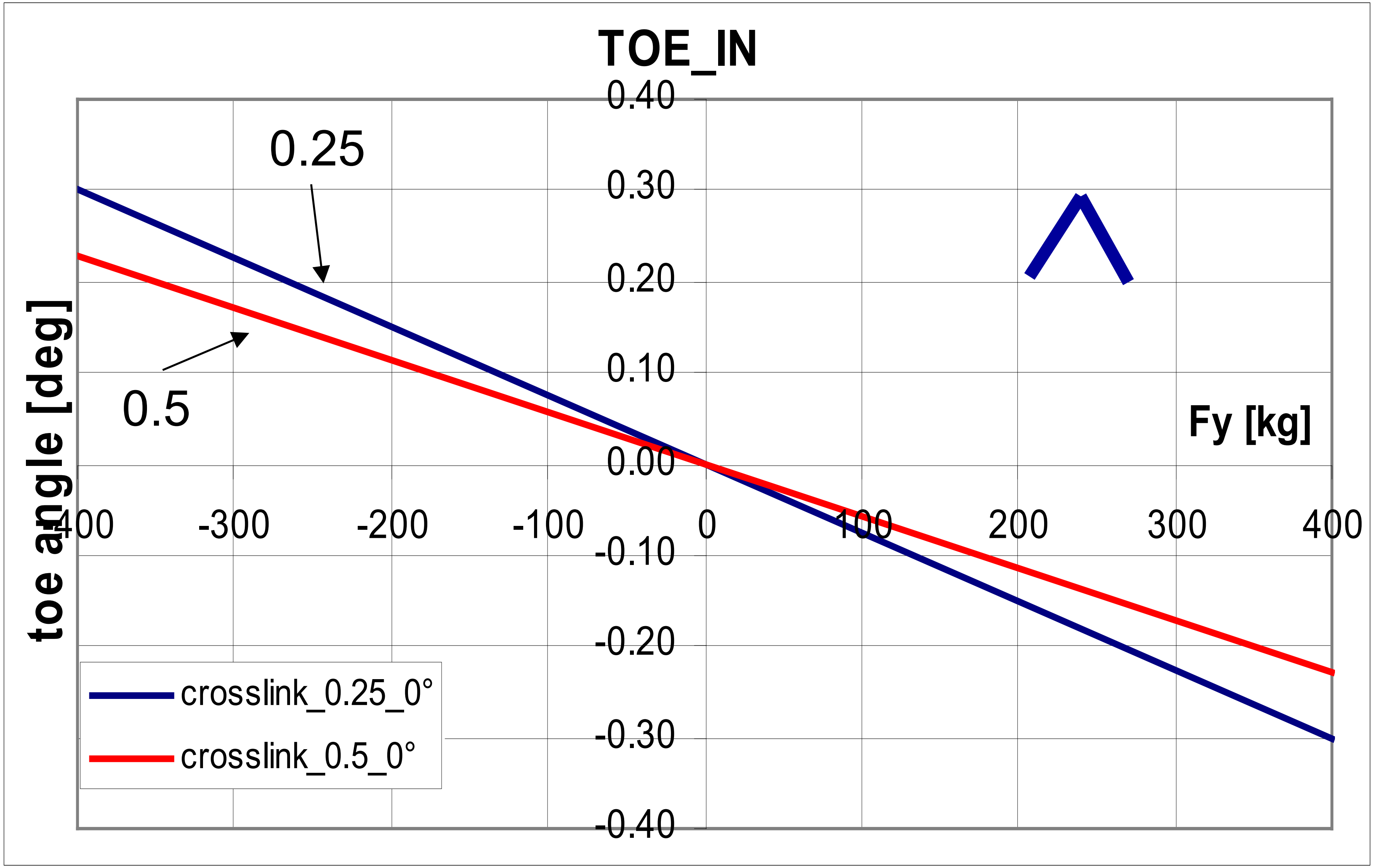
Twist Beam Suspension Analysis



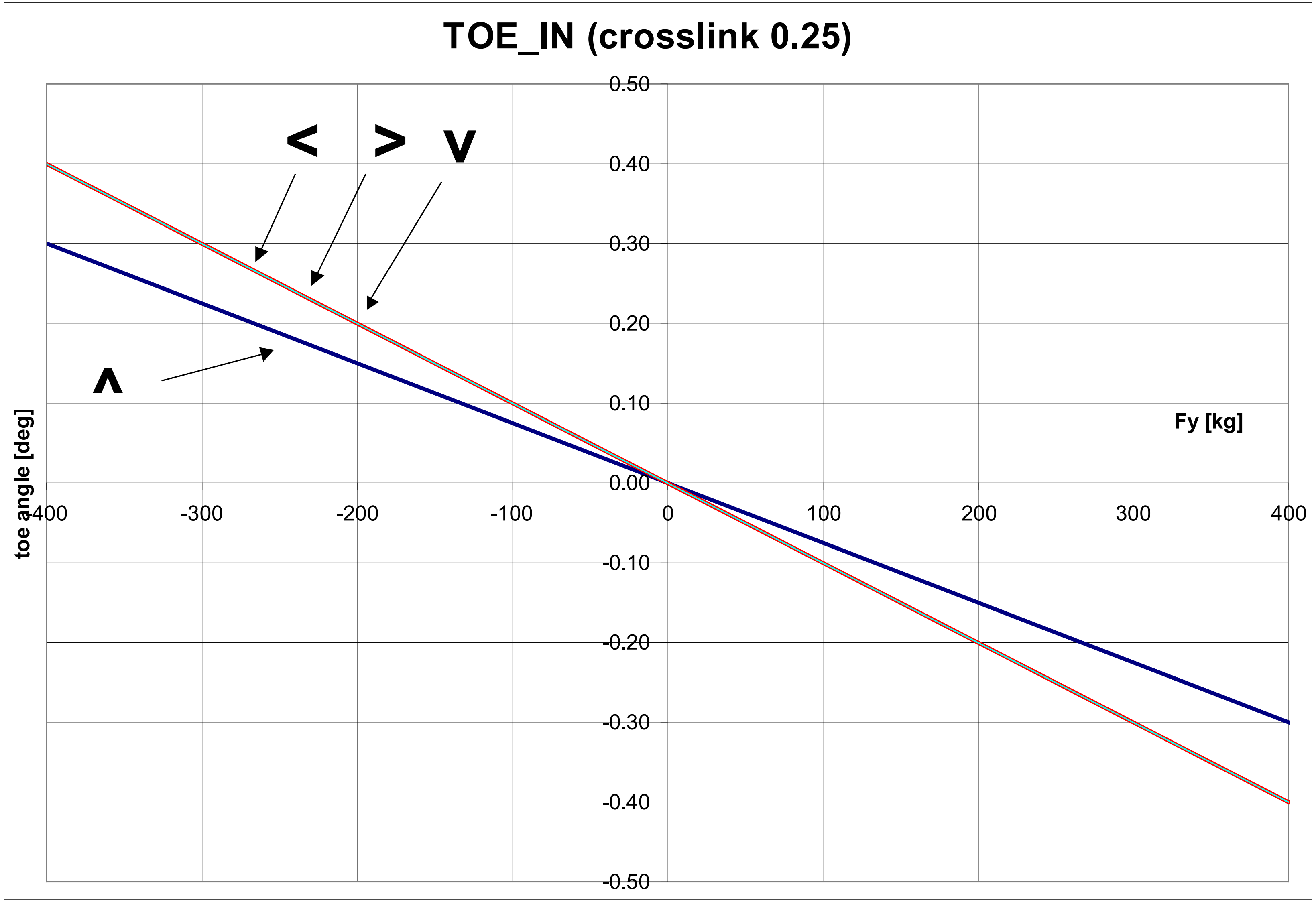
Suspension Analysis: Lateral Load



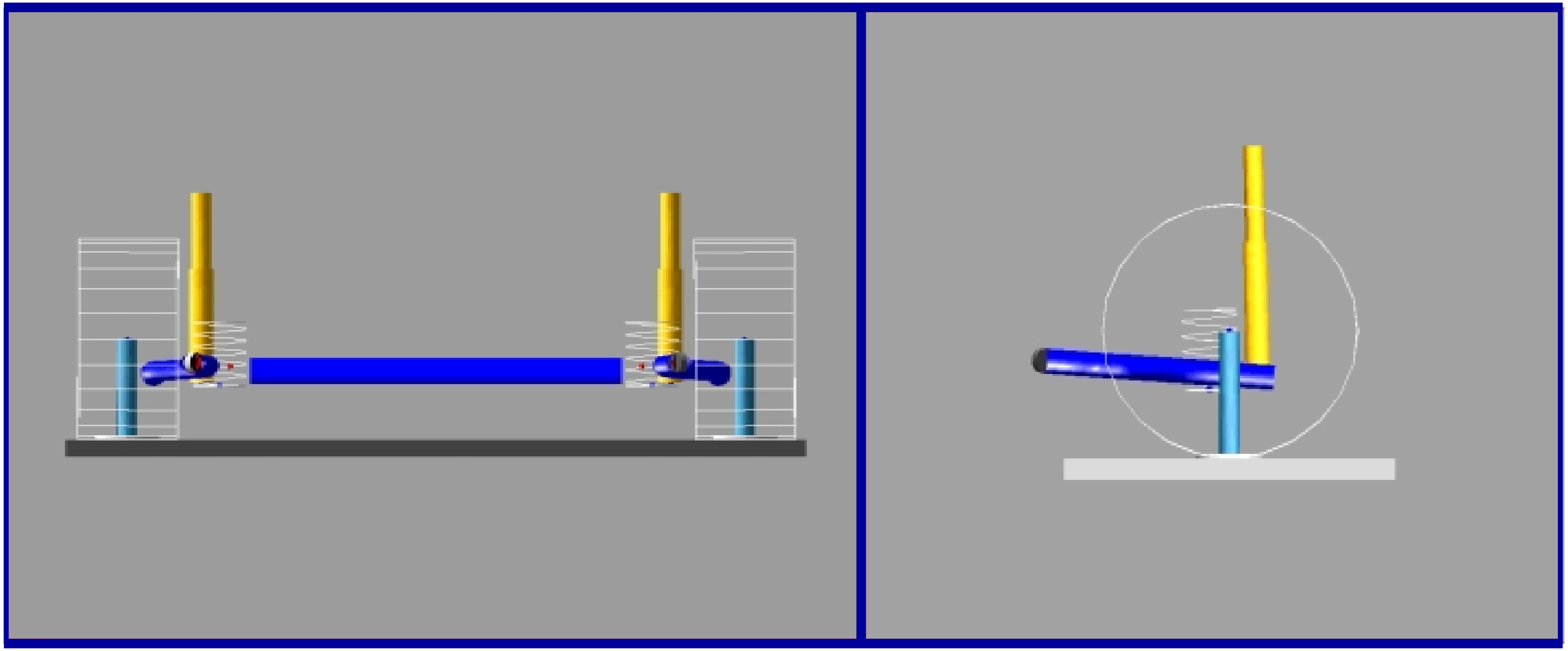
Lateral Force Fy



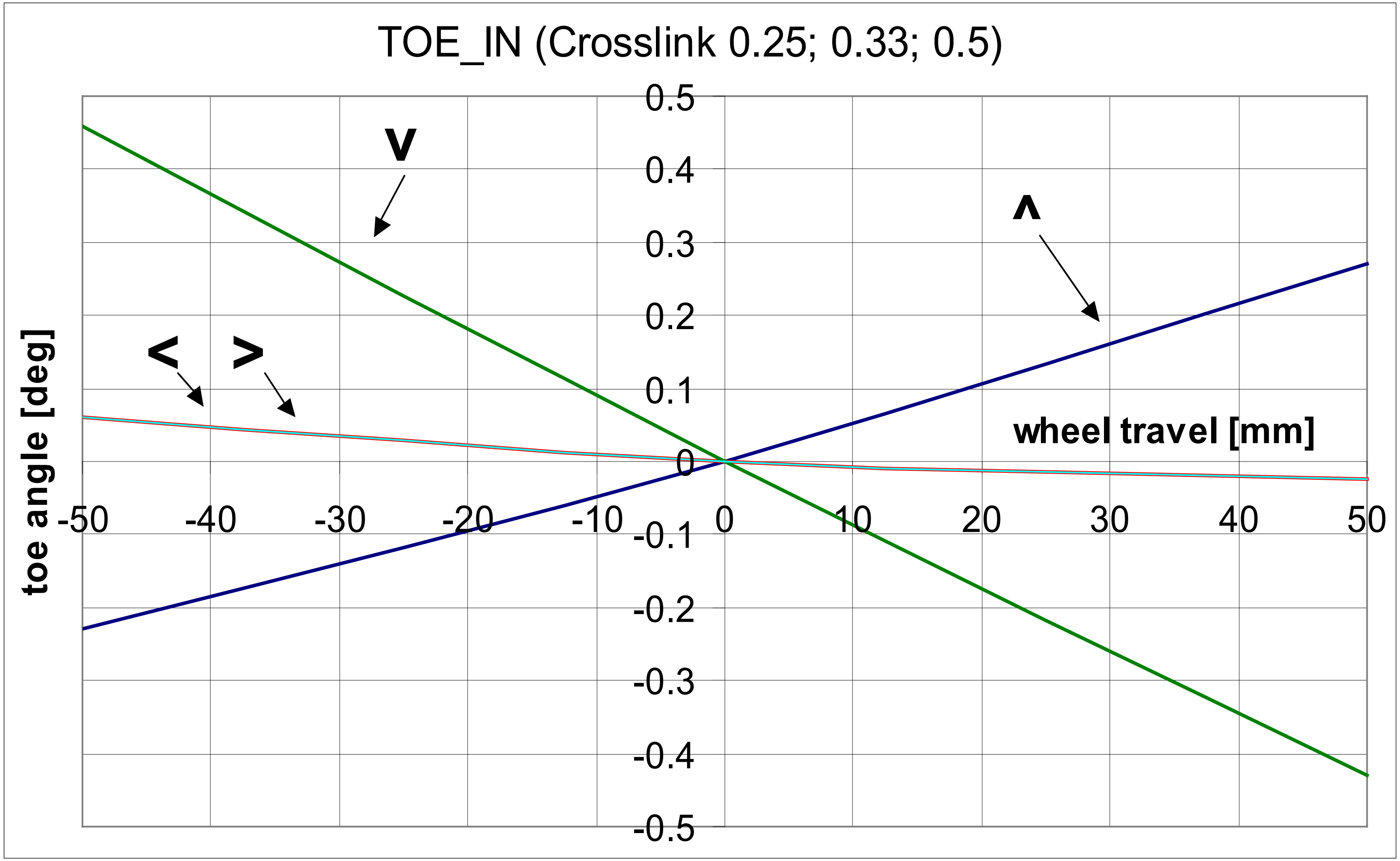
Lateral Force Fy



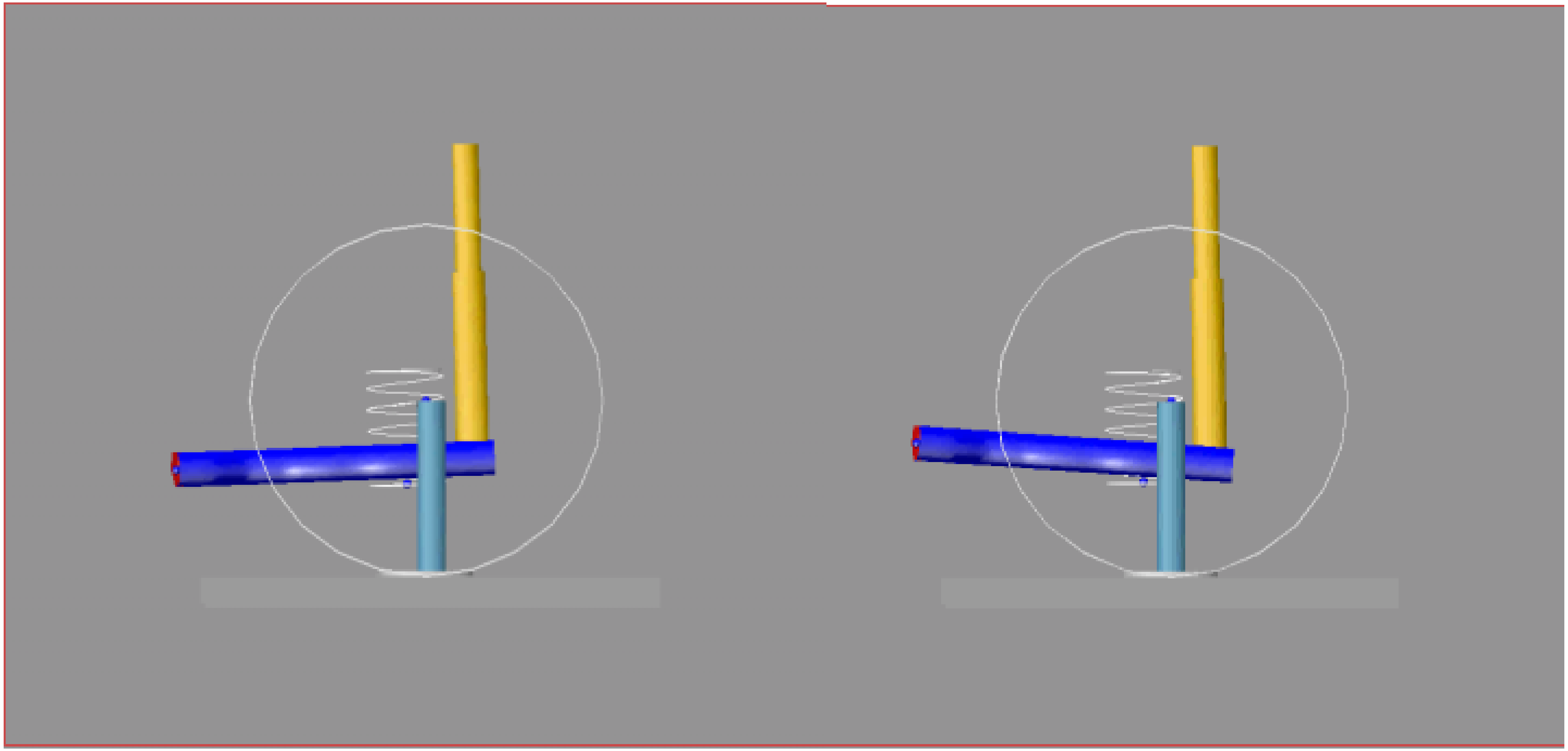
Suspension Analysis
OppositeTravel



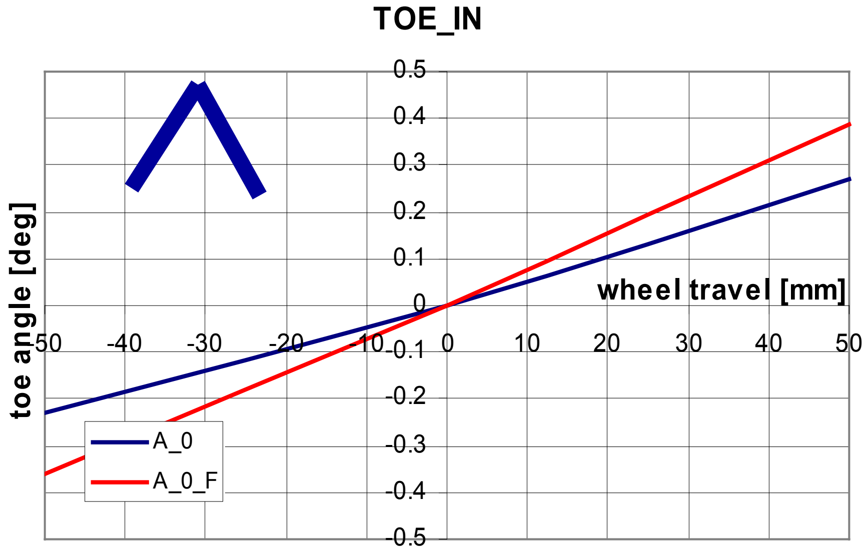
Opposite Travel

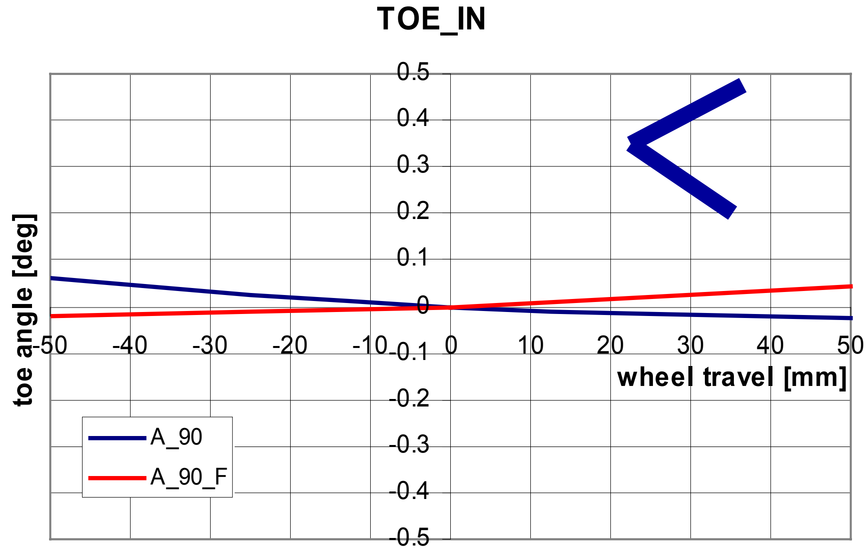


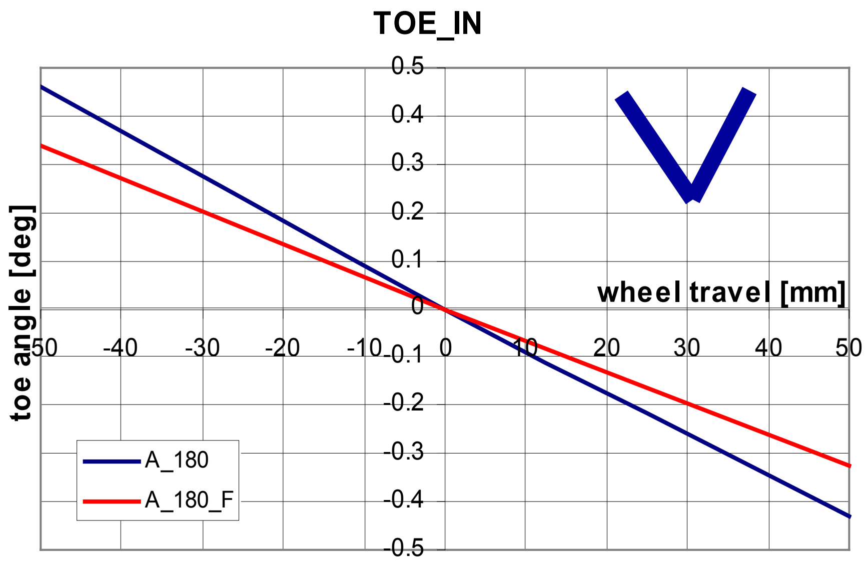
Suspension Analysis
OppositeTravel With Differents Vertical Loads

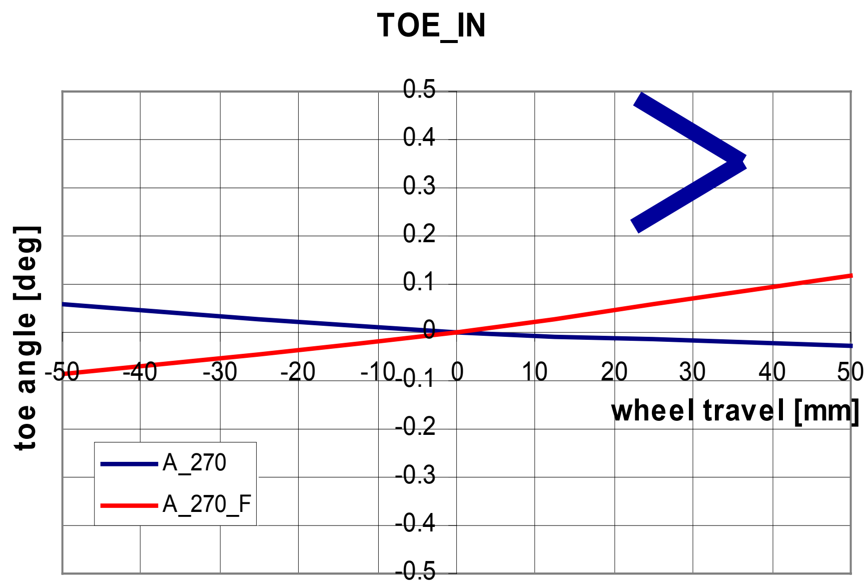


TOE Variation
with different loads (crosslink 0.25)

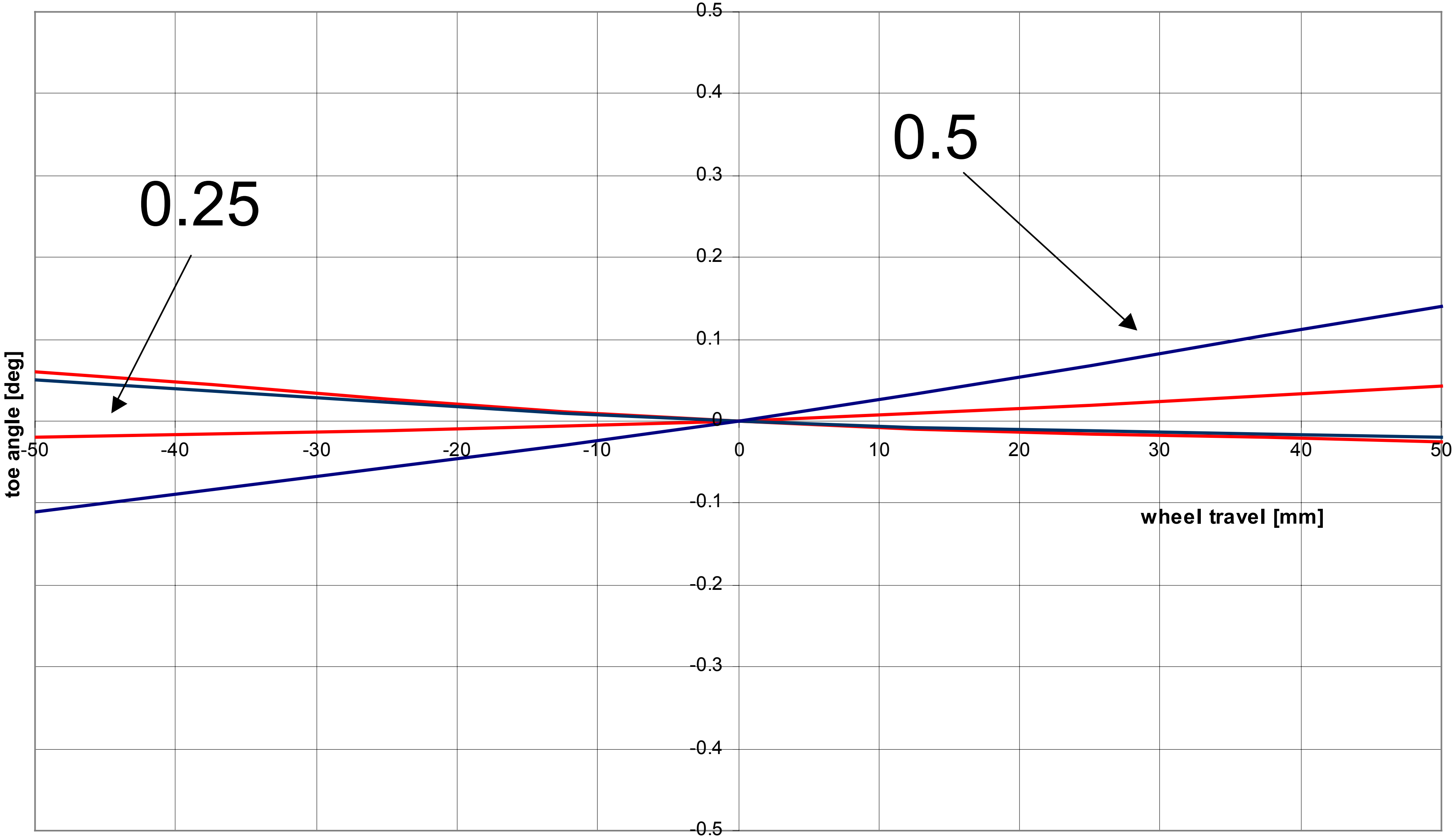




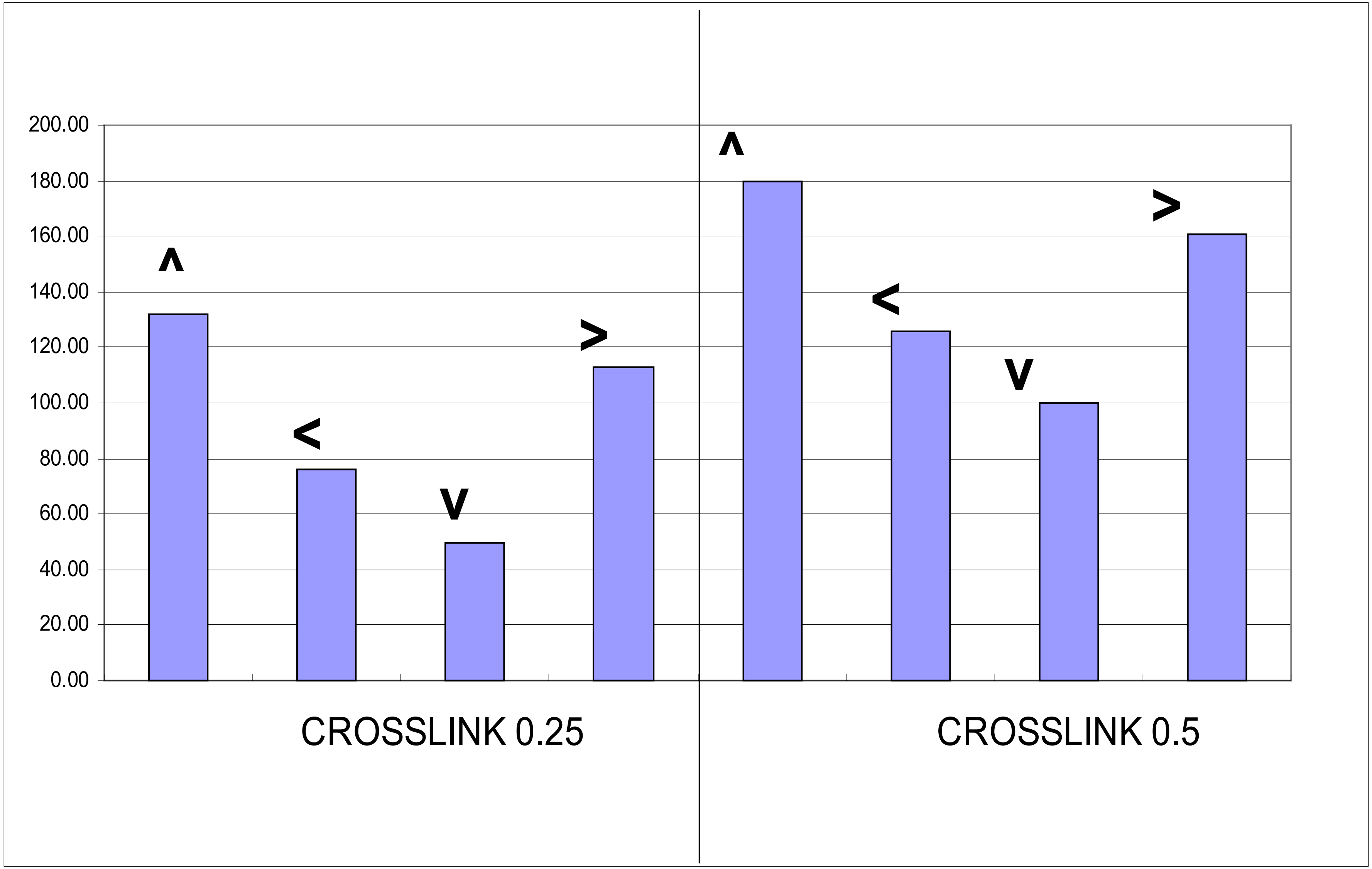




TOE Variation With different loads crosslink 0.25 and 0.5 (< orientation)



Roll Center Height

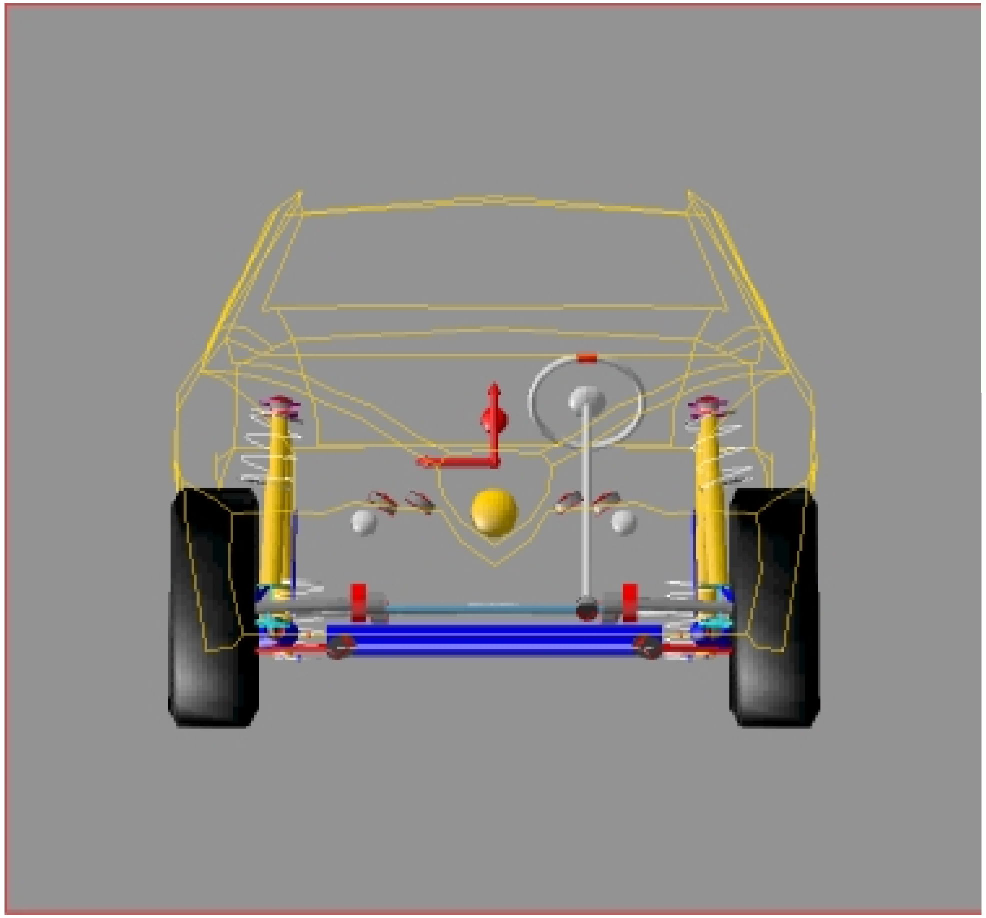


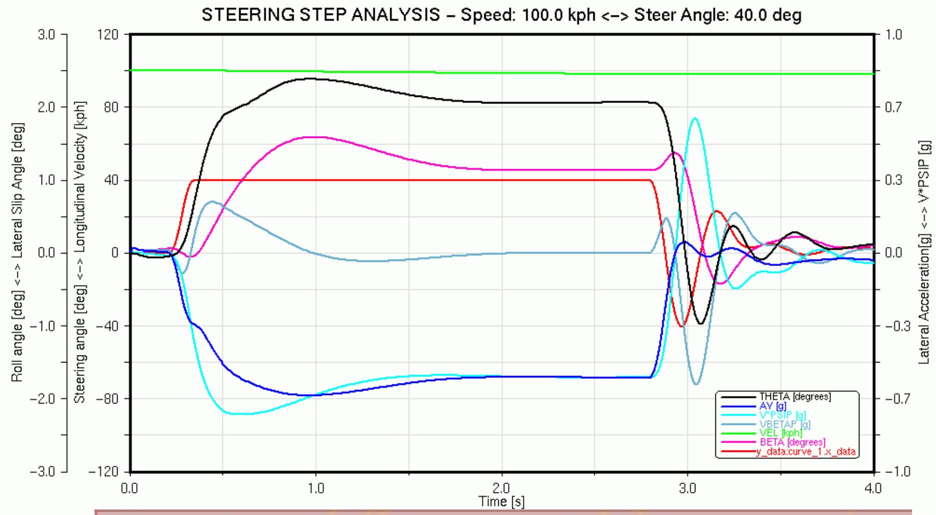
Virtual Bench Test Sinthesys

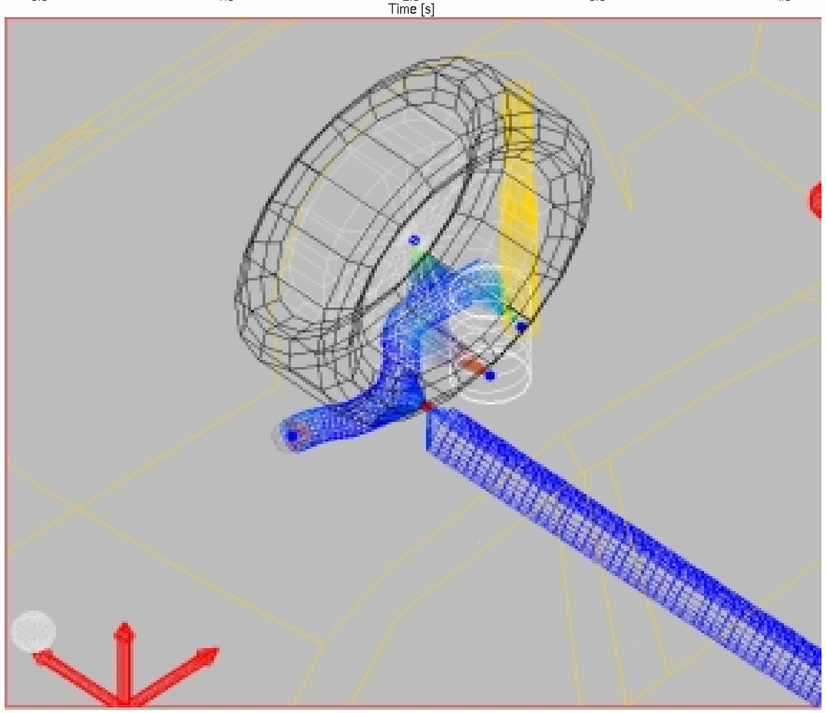
- **Cross link position (0.25, 0.33, 0.5)**
  - TOE with Lateral Load
  - Roll Center Height

- **Cross link orientation (^ , < , > , v)**
  - TOE Asimetric Wheel Travel
  - TOE Variation Empty and Full Load

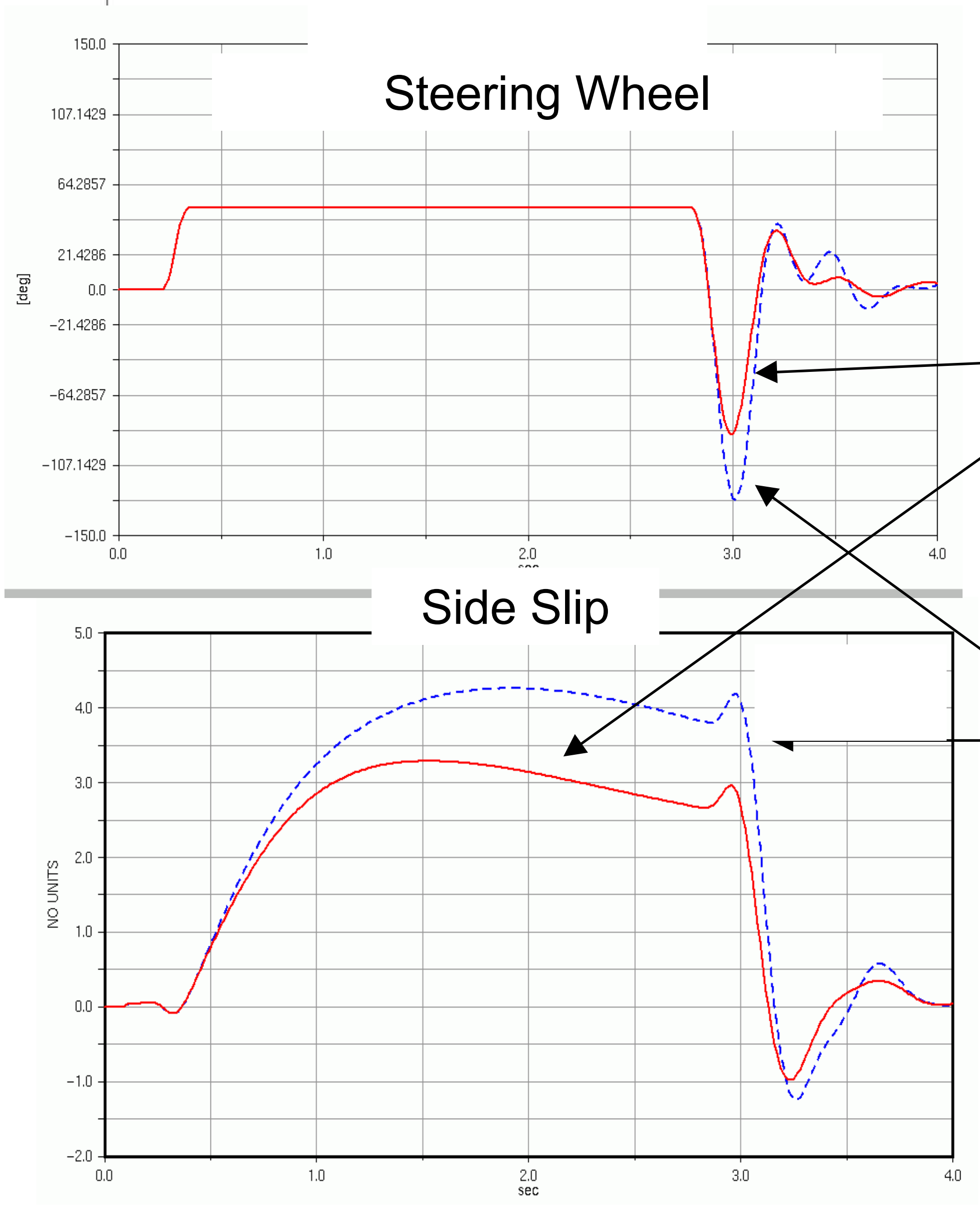
Full-Vehicle Analyses: Steering Wheel Step







Full-Vehicle Analyses: Steering Wheel Step



Roll Center

H = 80 mm

Roll Center

H = 150 mm

CLOSED LOOP SIMULATION

- By a simple twist beam model (FBG generated) it is possible to realize a closed loop simulation to optimize vehicle handling behaviour
- To compare different twist beam means to use the same total Roll Stiffness and Front/Rear Roll Stifness Distribution. This produces different TOE and Roll Center conditions and starts the Closed Loop Simulation
- The most suitable twist beam solutions found with FBG have to be completed with CAD Design, FEM Analysis and Real Prototype Bench Testing

CONCLUSIONS

- FBG is a very powerful method to optimize Twist Beam Rear Suspension
- Easy closed loop simulation is the main advantage of the method
- With this tool in A/Car environment it has been possible to optimize handling behaviour of a middle class car with Mcpherson front and Twist Beam rear
- Vehicle dynamics engineers have mainly worked on the project
- Design engineers for CAD/FEM simulations and real prototypes bench test have concentrated their work on the 3 best solutions