

# Analysis of Vehicle - Suspension system under Vertical, Pitching & Rolling motion

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# Suspension

Suspension is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two.



# Why suspension is required?

The suspension on a vehicle serves multiple purposes:

- It provides a stable platform from which to control the vehicle.
- It provides a way to isolate the chassis and driver from the shocking jolts that the tires experience going over anything but a glass-smooth surface.
- It provides a way to keep all the vehicle's tires in contact with an uneven surface.
- It provides damping of oscillations that rubber tires, springs and uneven surfaces naturally create.

# Components of Suspension

- Tires
- Wheels
- Brakes
- Knuckles/Uprights
- Wishbones/Links
- Axles
- Steering

# Knuckles/Uprights

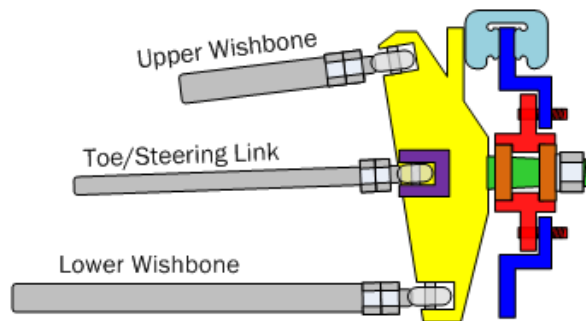
- The upright or knuckle attaches the wheel, brake rotor, hub, brake caliper and steering arm to the vehicle.
- The upright is attached to the vehicle using the upper and lower wishbones which have ball joints or rod-ends. This allows the upright to move vertically and to rotate about the kingpin axis.

## Non-Driven Wheel Upright

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Build Your

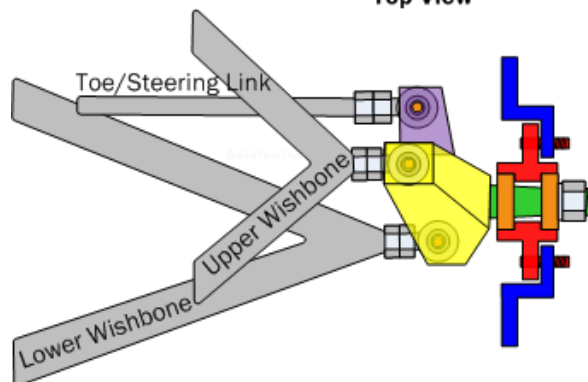
Side View



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Top View



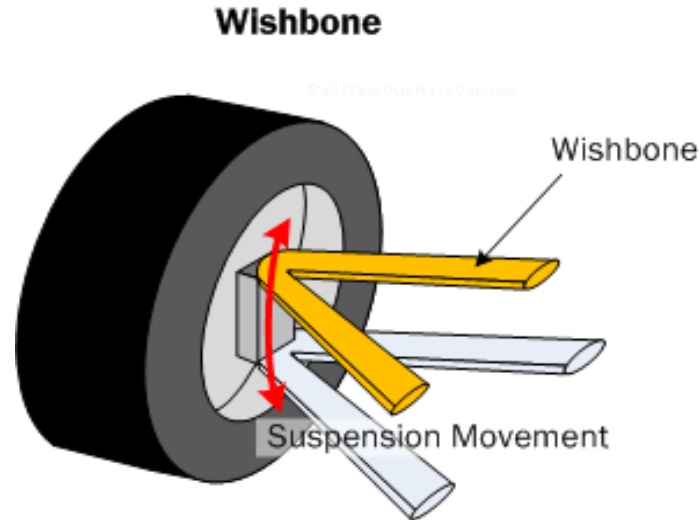
Build Your

Build Your

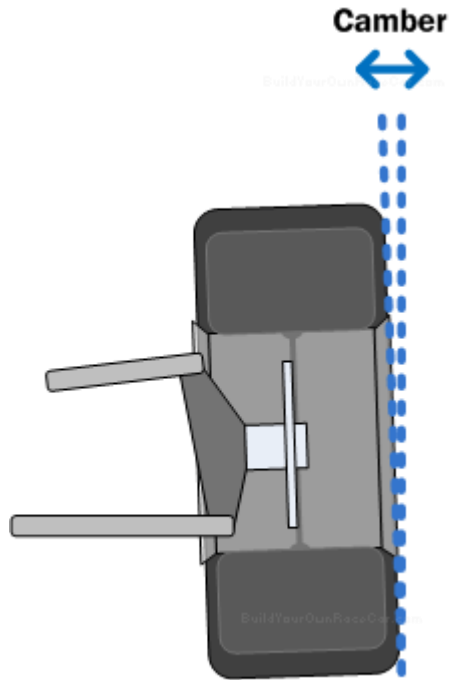
-  Upright/Knuckle
-  Spindle
-  Hub
-  Hub ("Wheel") Bearings
-  Brake Caliper
-  Brake Disc
-  Toe/Steering Link

# Wishbones/Links

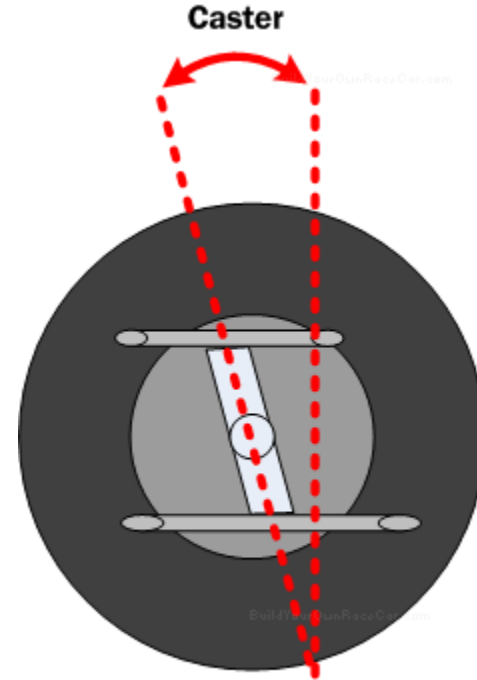
- Wishbones, links and axles connect the previously mentioned upright or knuckle to the car chassis.
- The goal is to control lateral, longitudinal and vertical motion of the wheels.



# Camber Angle & Caster Angle



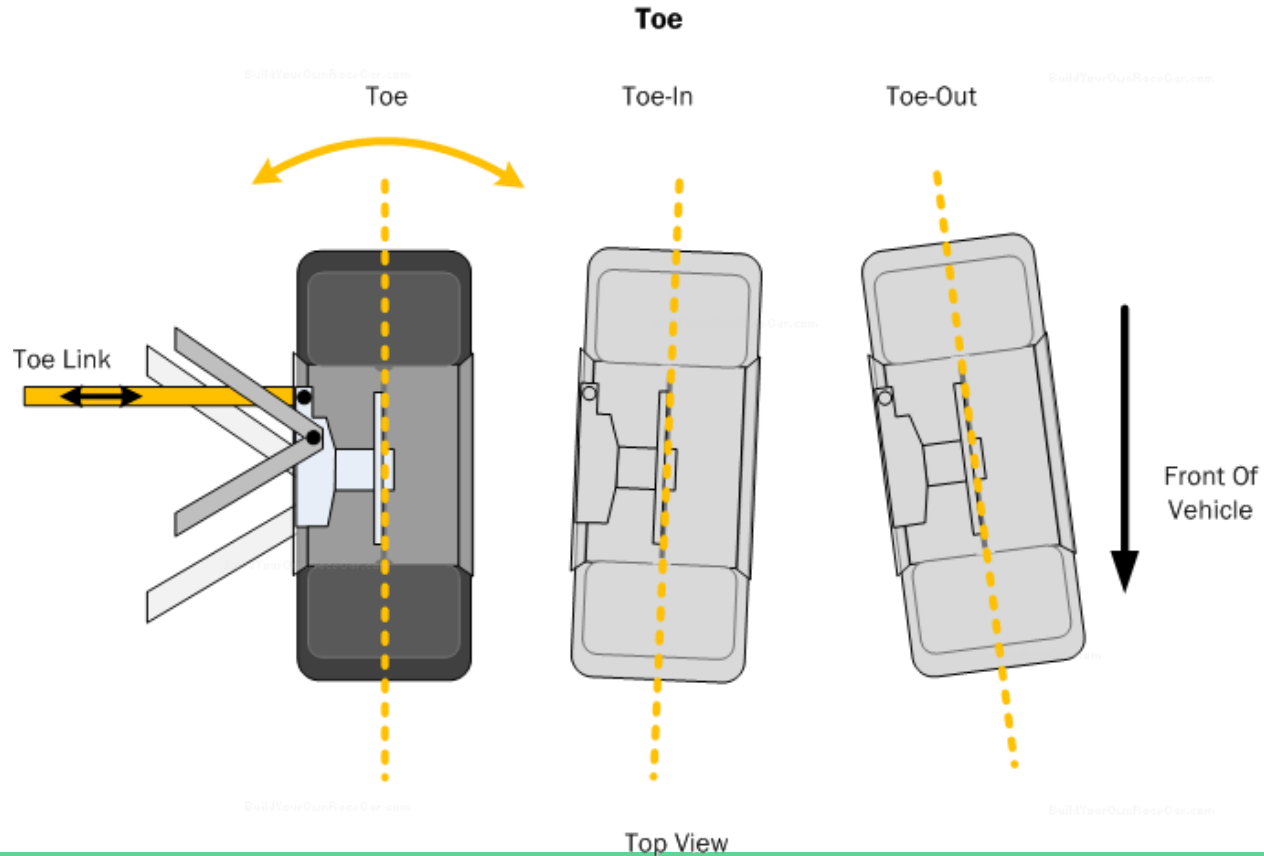
Front View



Side View



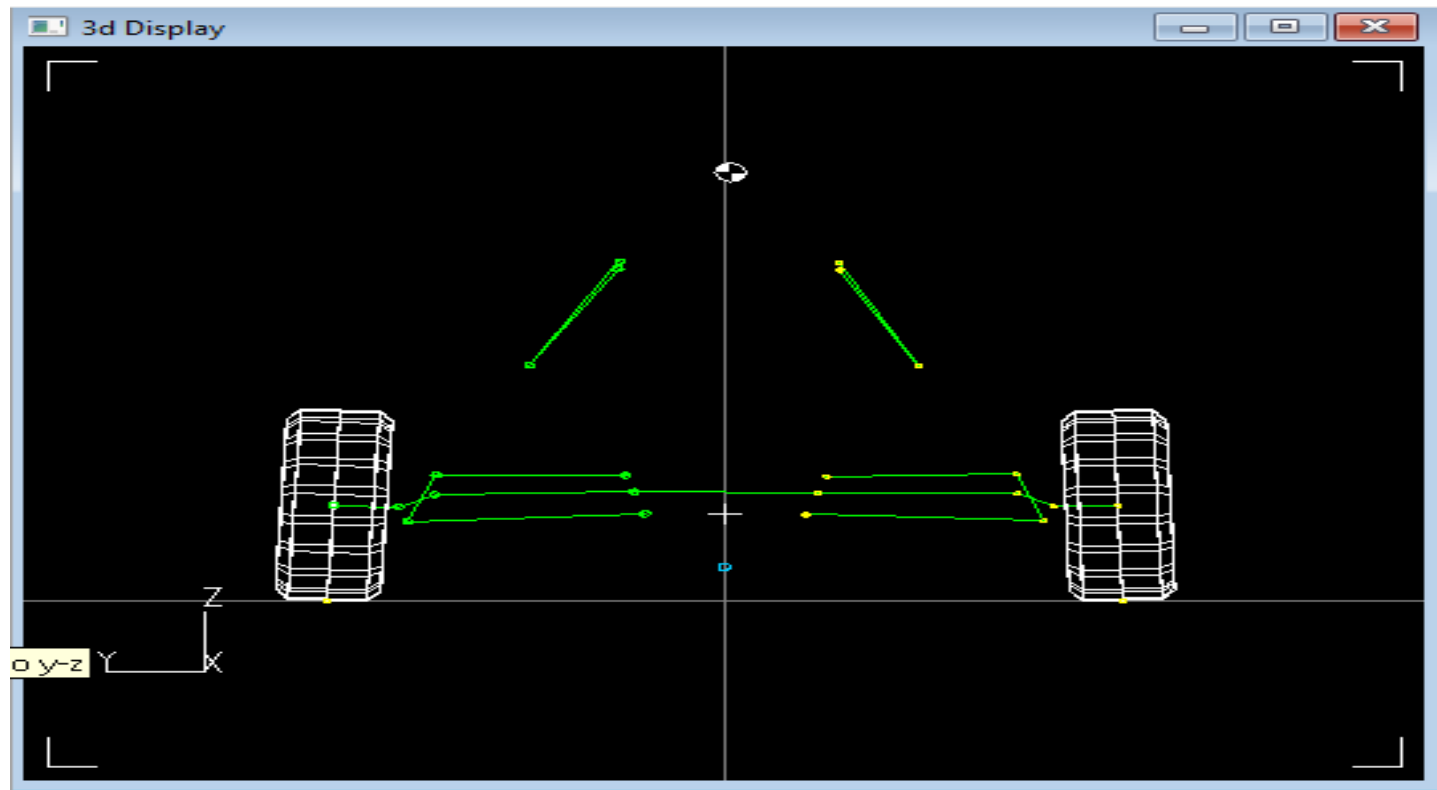
# Toe In/Out Angle



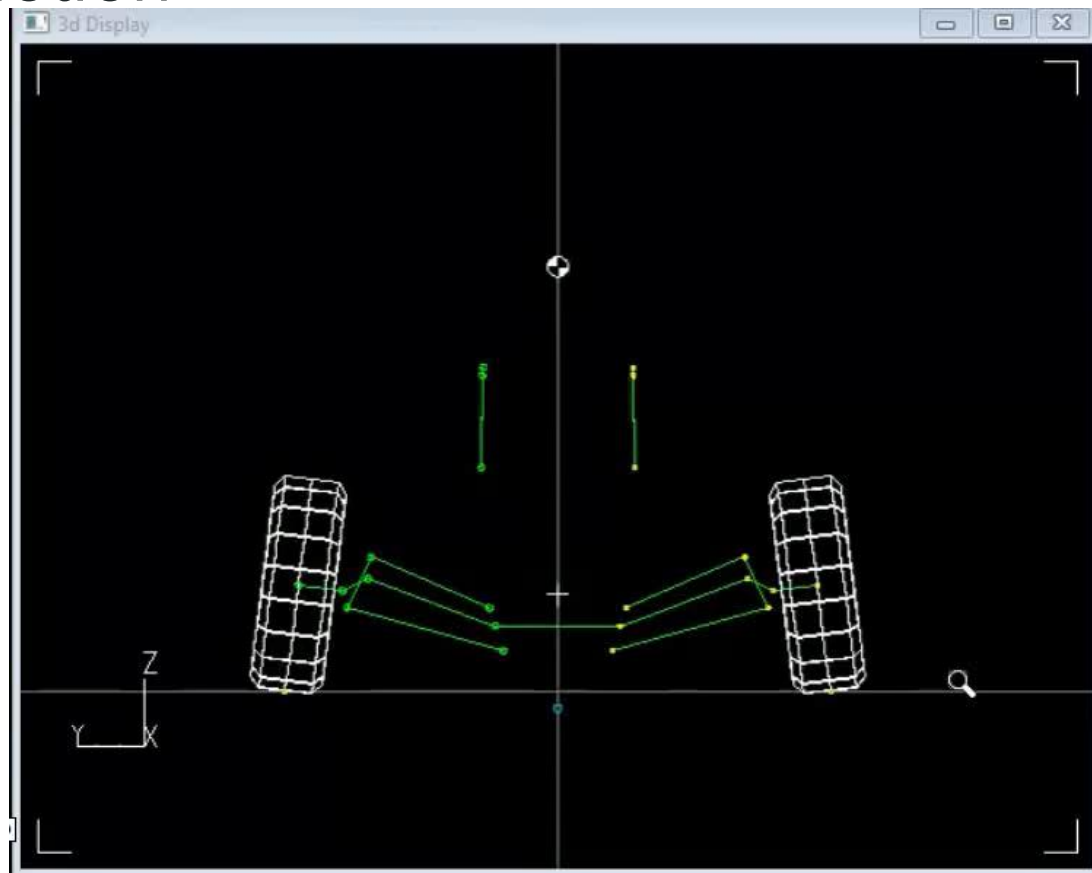
All suspensions seek to control the movement of the tires in three ways:

1. Laterally – Controlling side-to-side movement
2. Longitudinally – Controlling forward/backward movement
3. Vertically – Controlling up and down movement

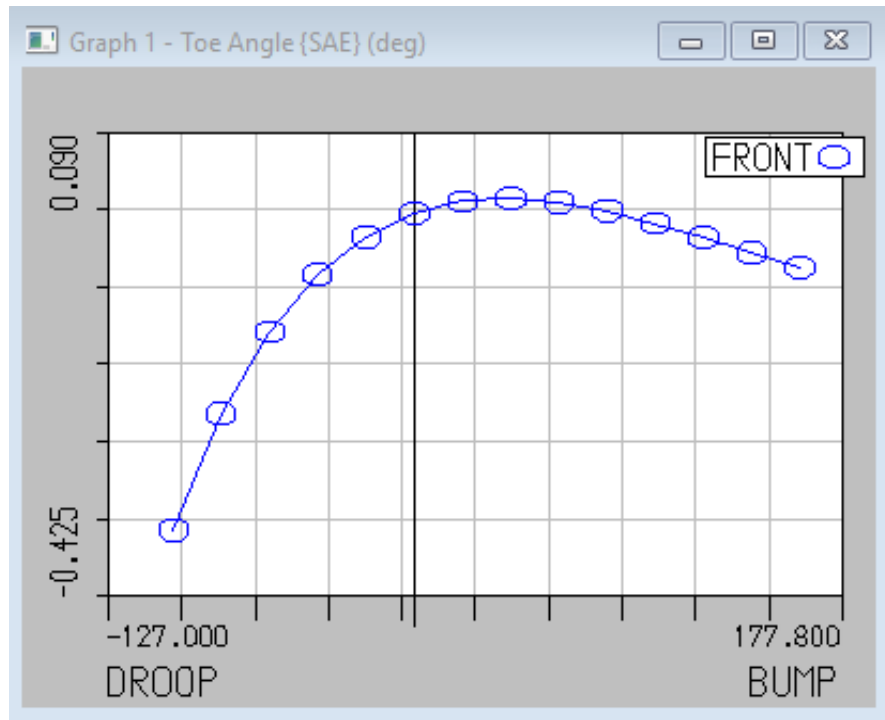
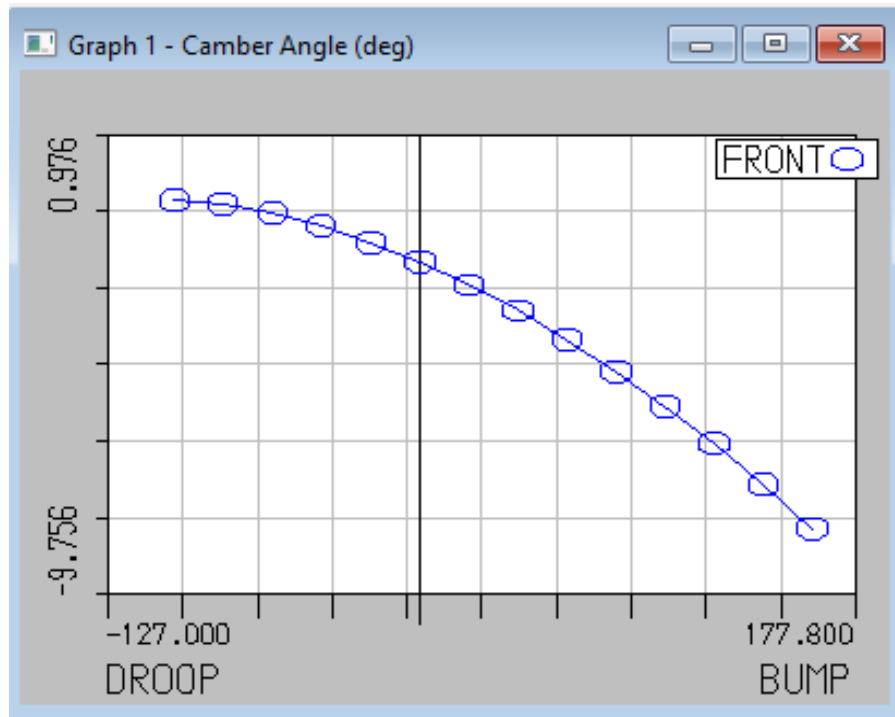
# Designing in Lotus



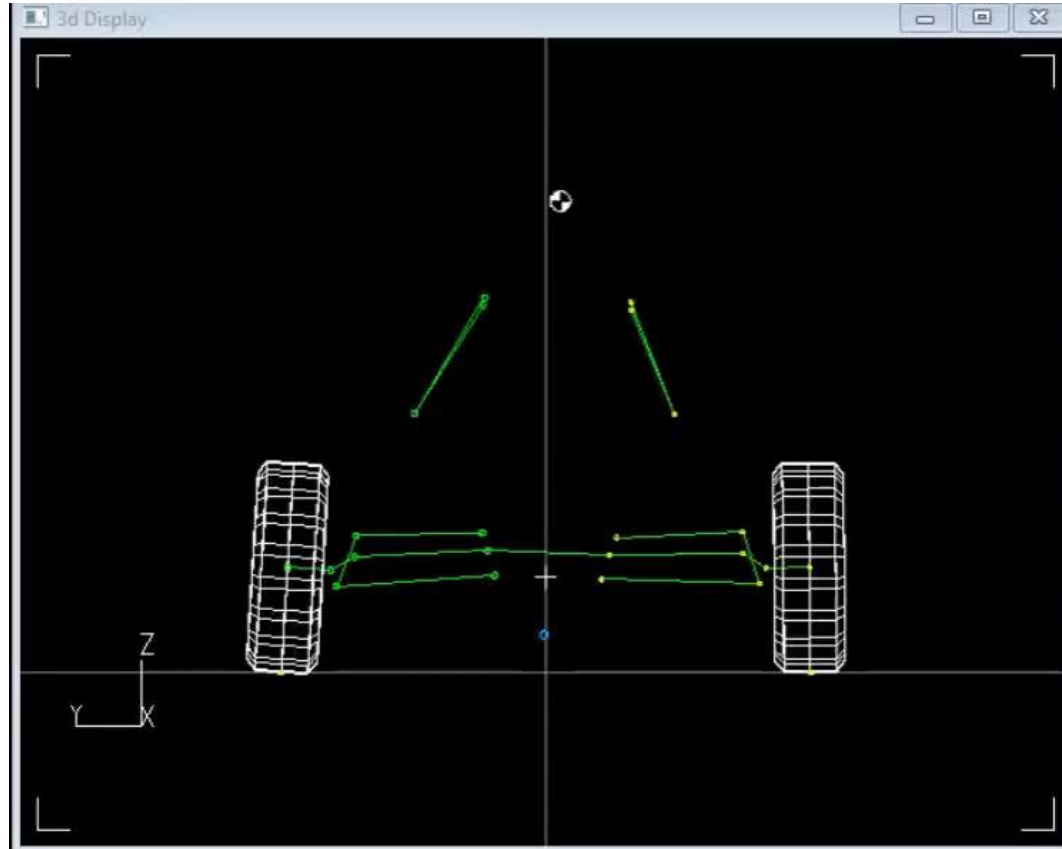
# Vertical Motion



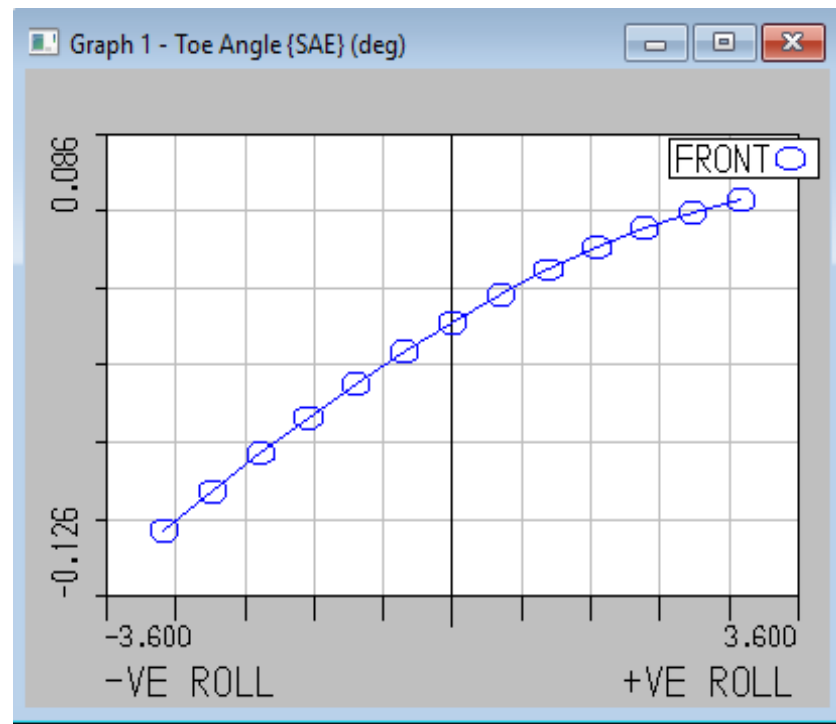
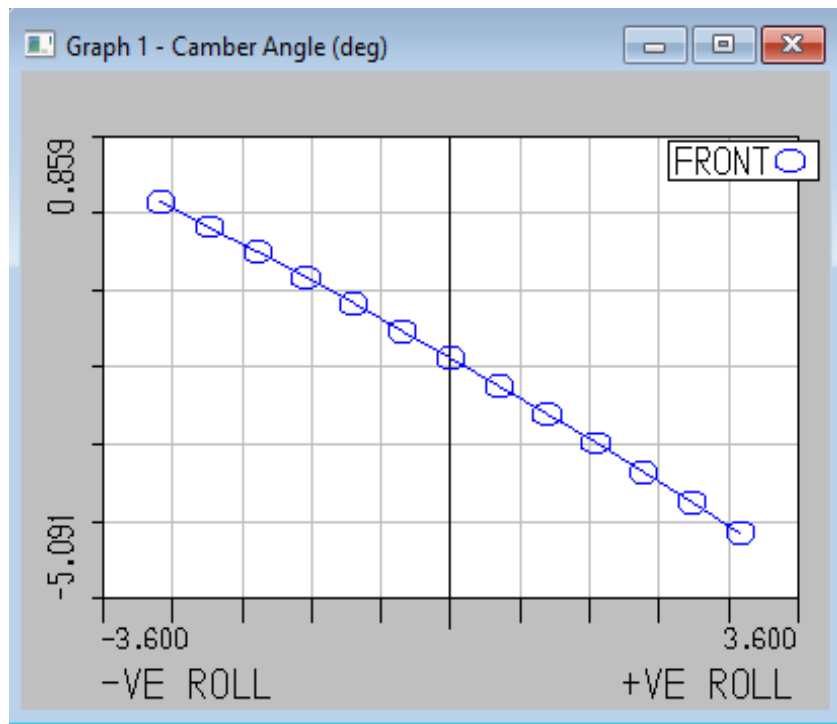
# Vertical Motion



# Rolling Motion



# Rolling Motion



# Simulation in CarSim

## Specs

- C-Class hatchback 2012 OSG
- Camber angle: -2 degrees
- 150 KW Engine
- Exotic w/o ABS
- Unsprung mass 71 Kg.

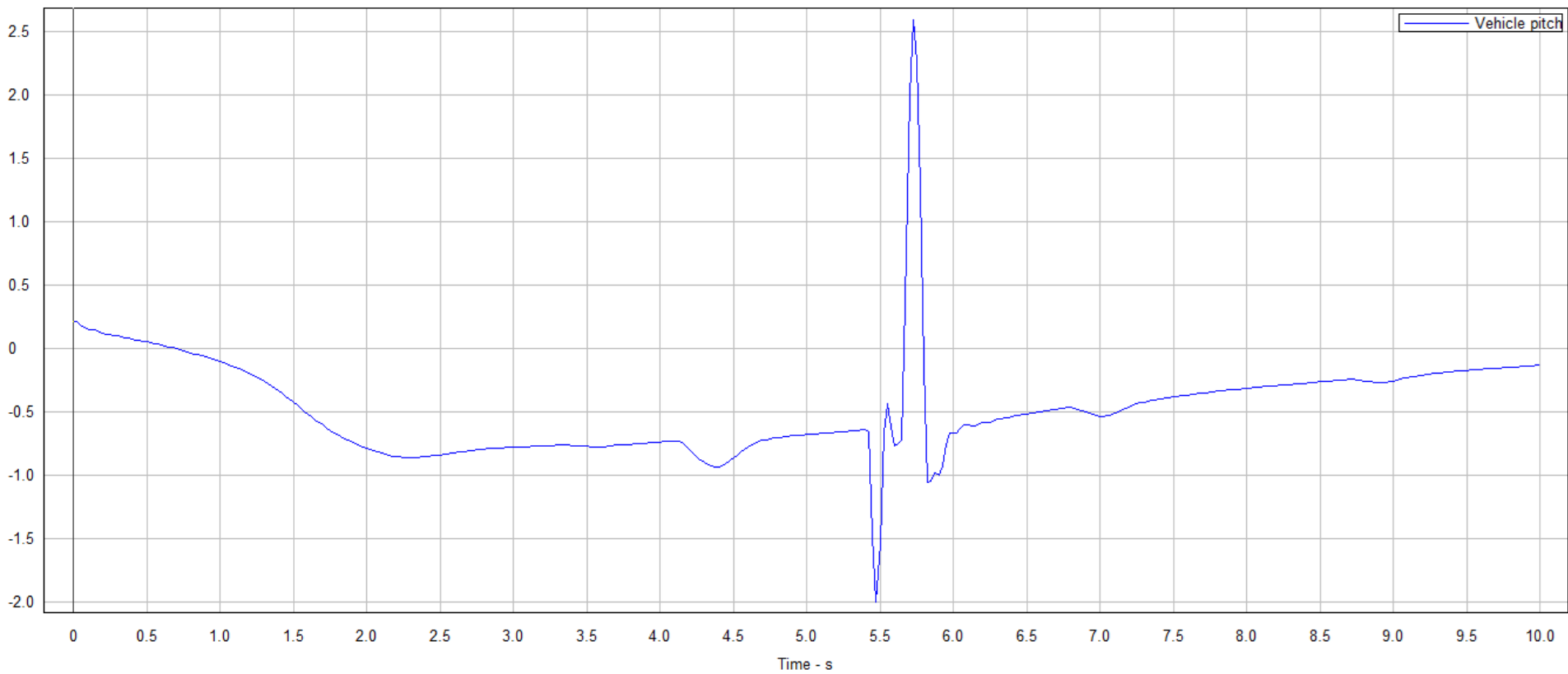


# Vertical Motion



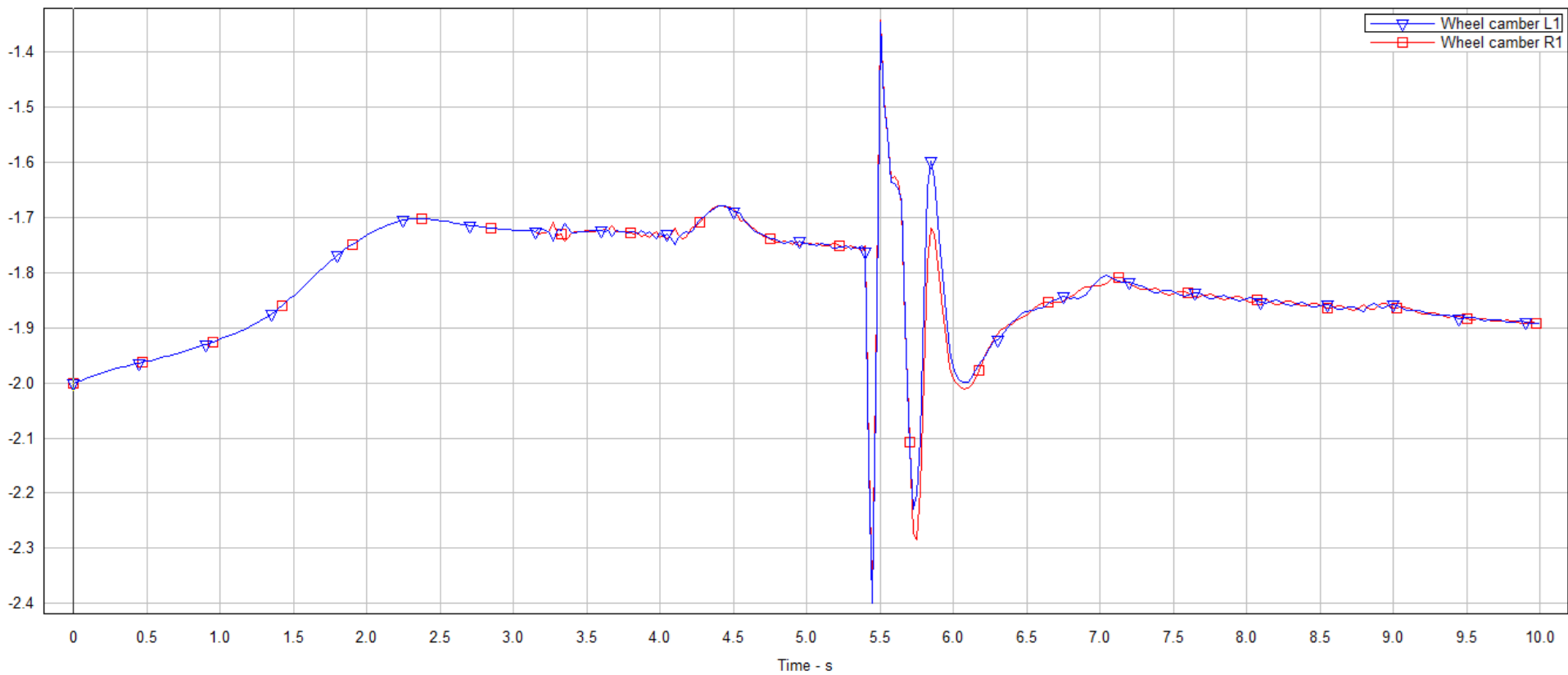
Pitch Angle of Sprung Masses : Baseline

Pitch, vehicle - deg



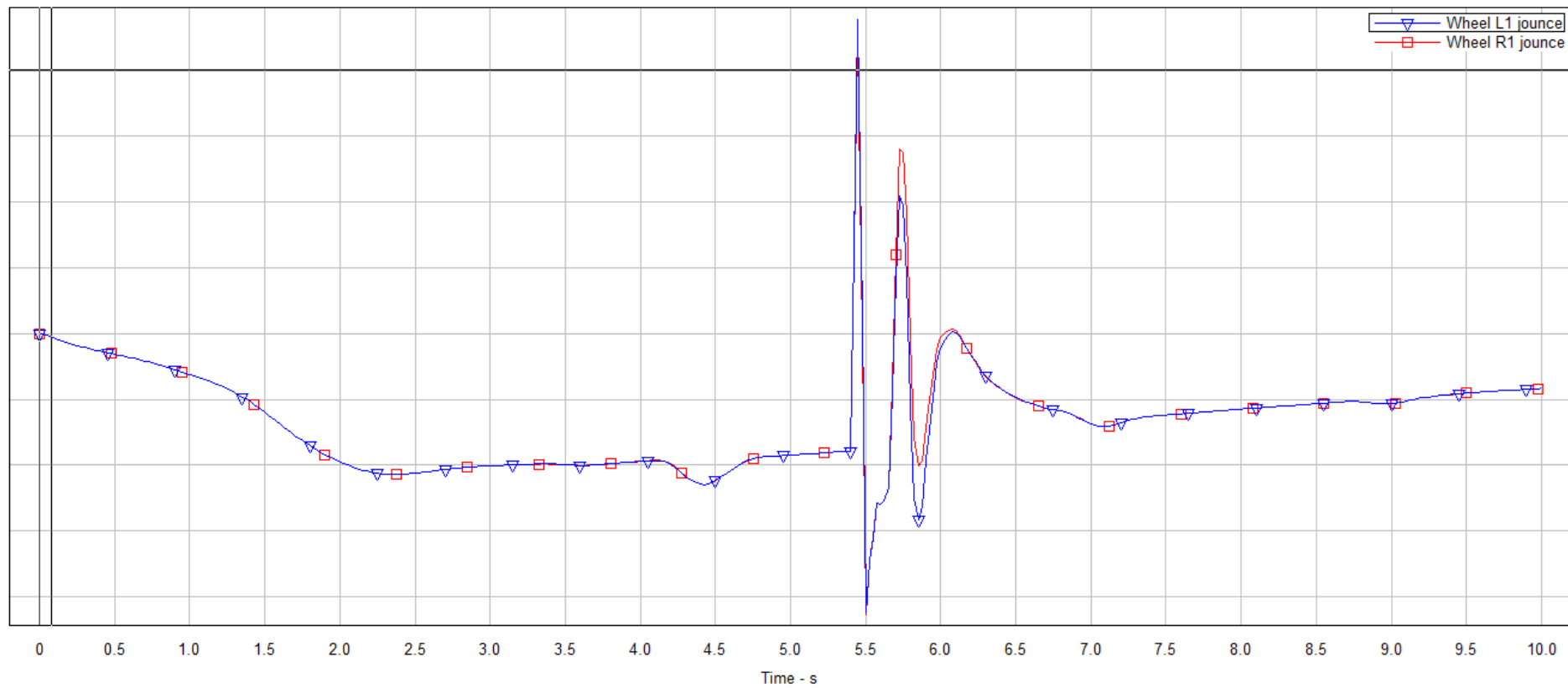
Camber - Front : Baseline

Angle - deg



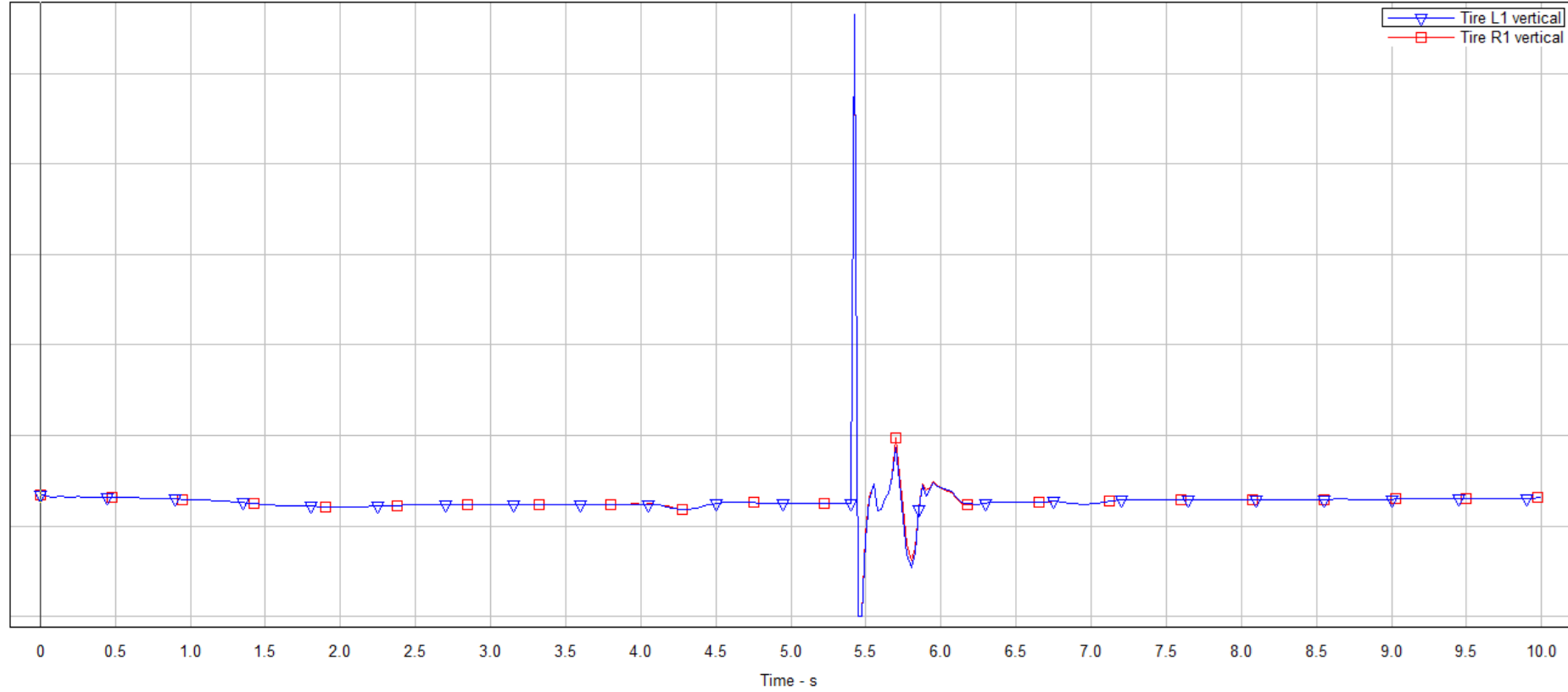
Jounce - Front : Baseline

Compression - mm



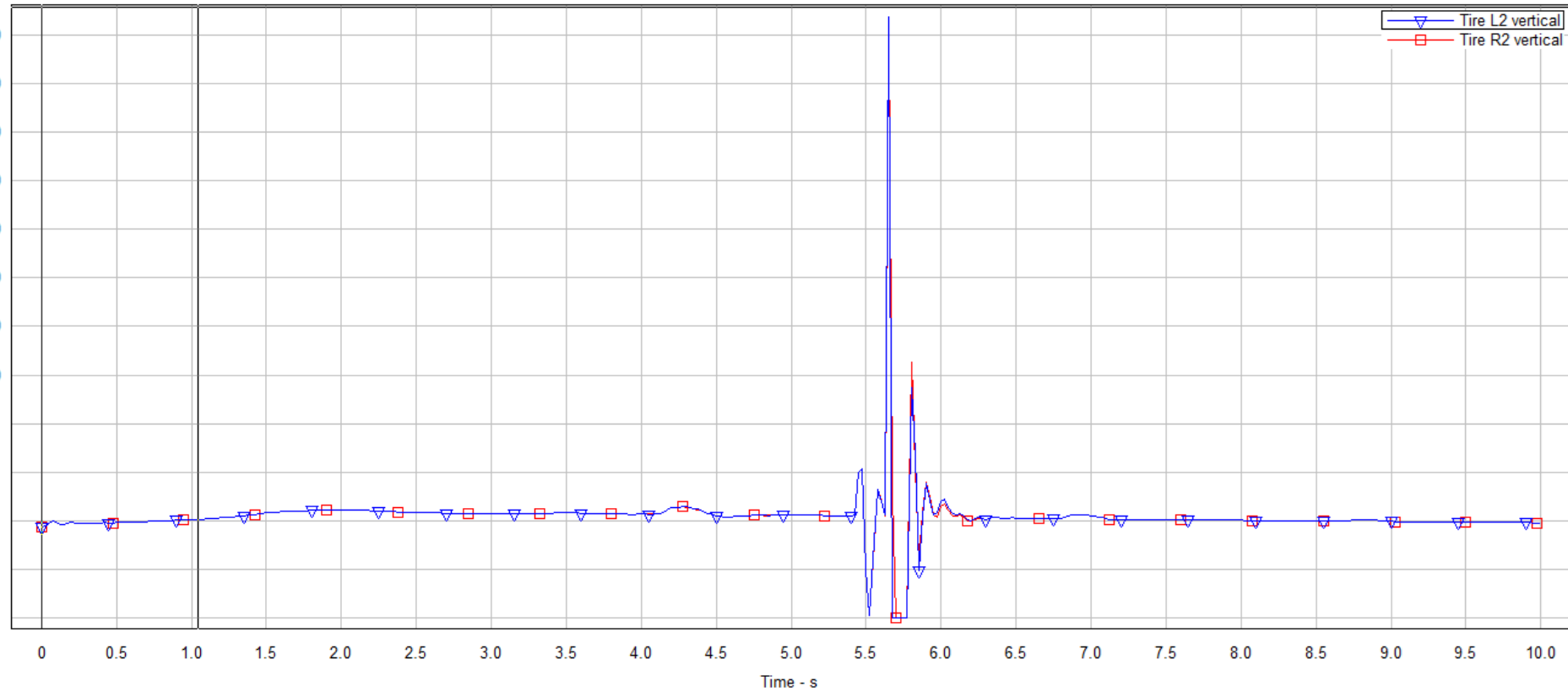
Vertical Forces - Front : Baseline

Force - N



Vertical Forces - Rear : Baseline

Force - N

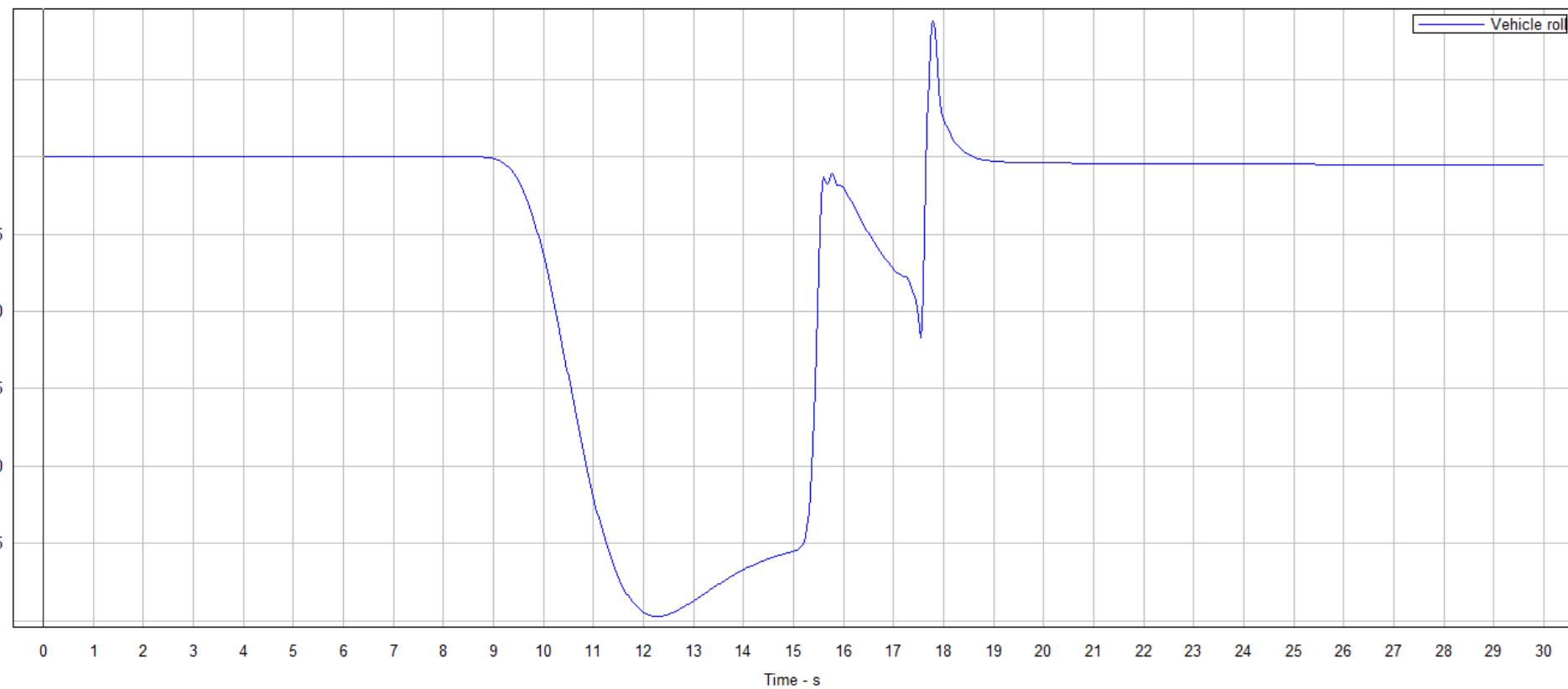


# Rolling Motion



Roll Angle of Sprung Masses : Baseline

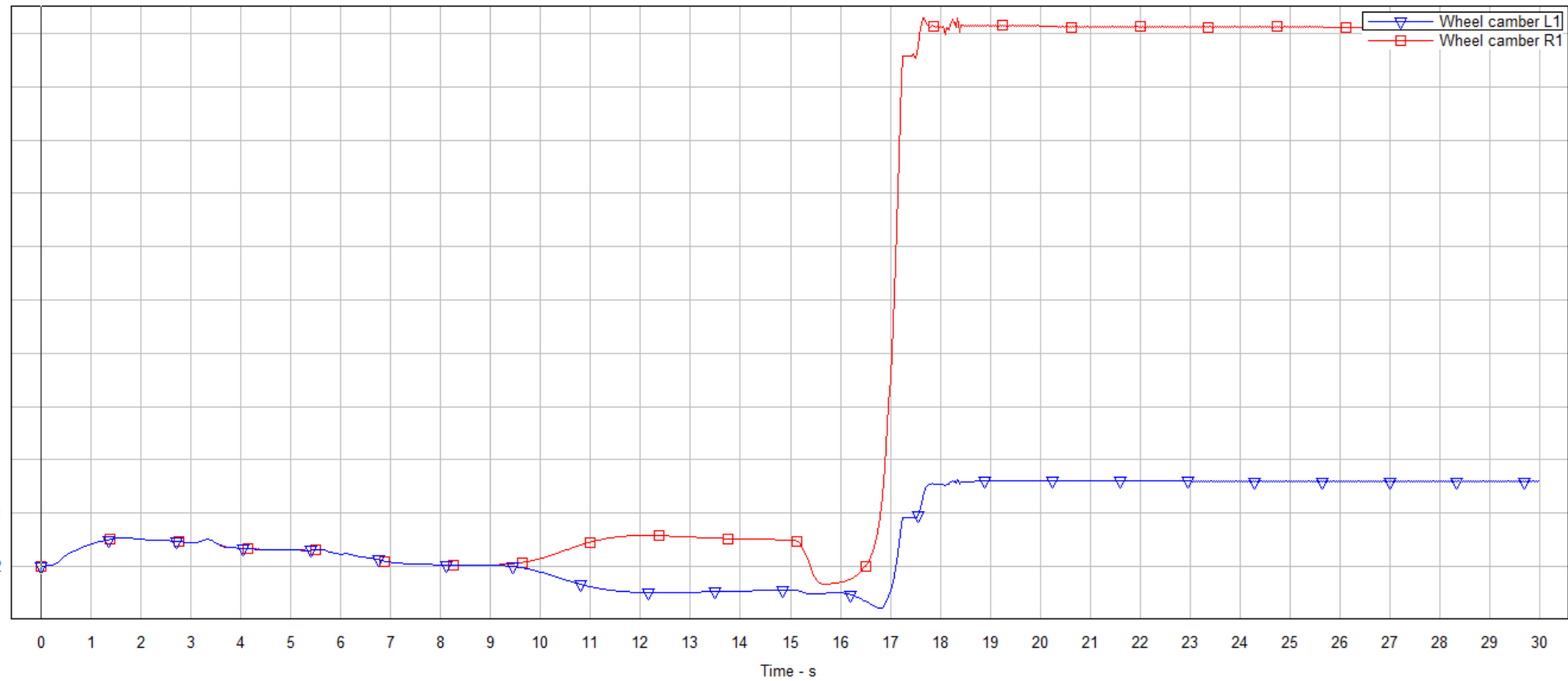
Roll, vehicle - deg



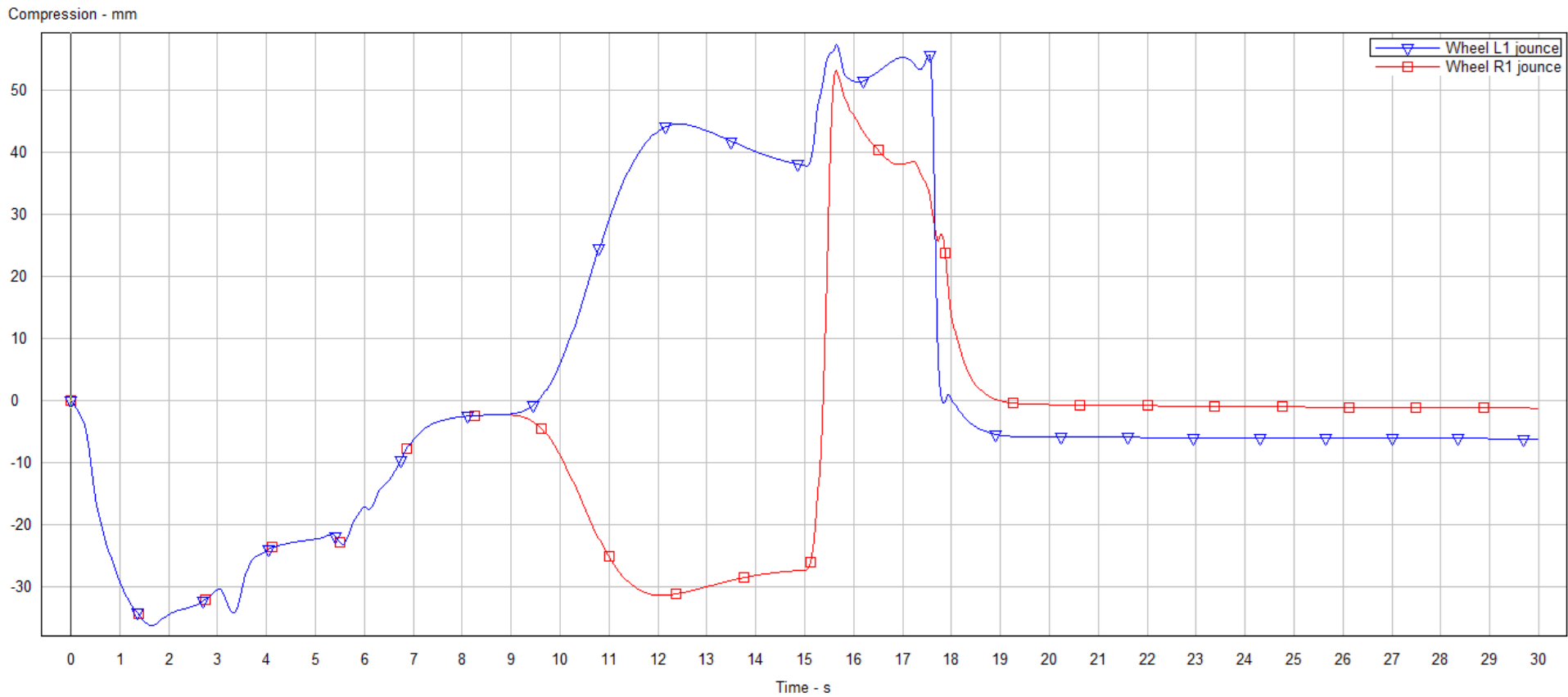


Camber - Front : Baseline

Angle - deg

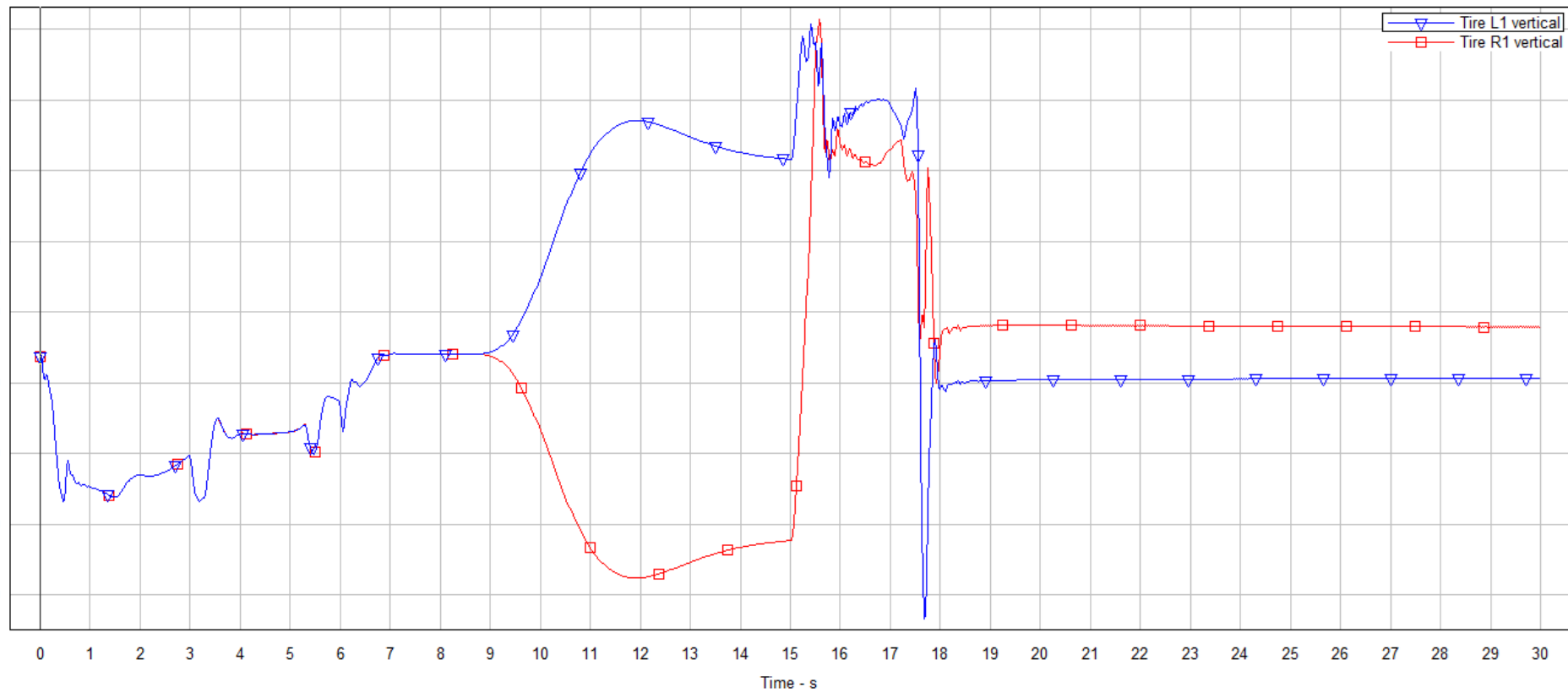


Jounce - Front : Baseline



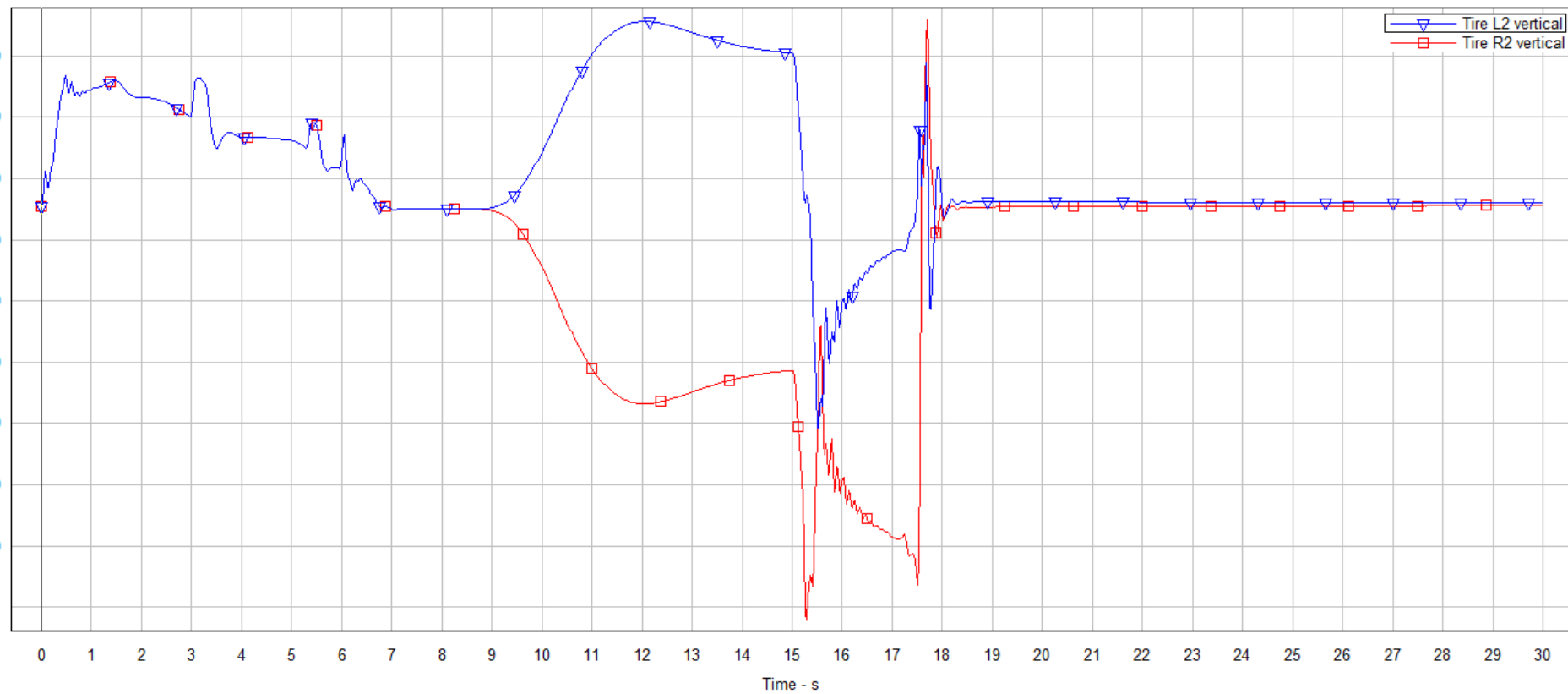
Vertical Forces - Front : Baseline

Force - N

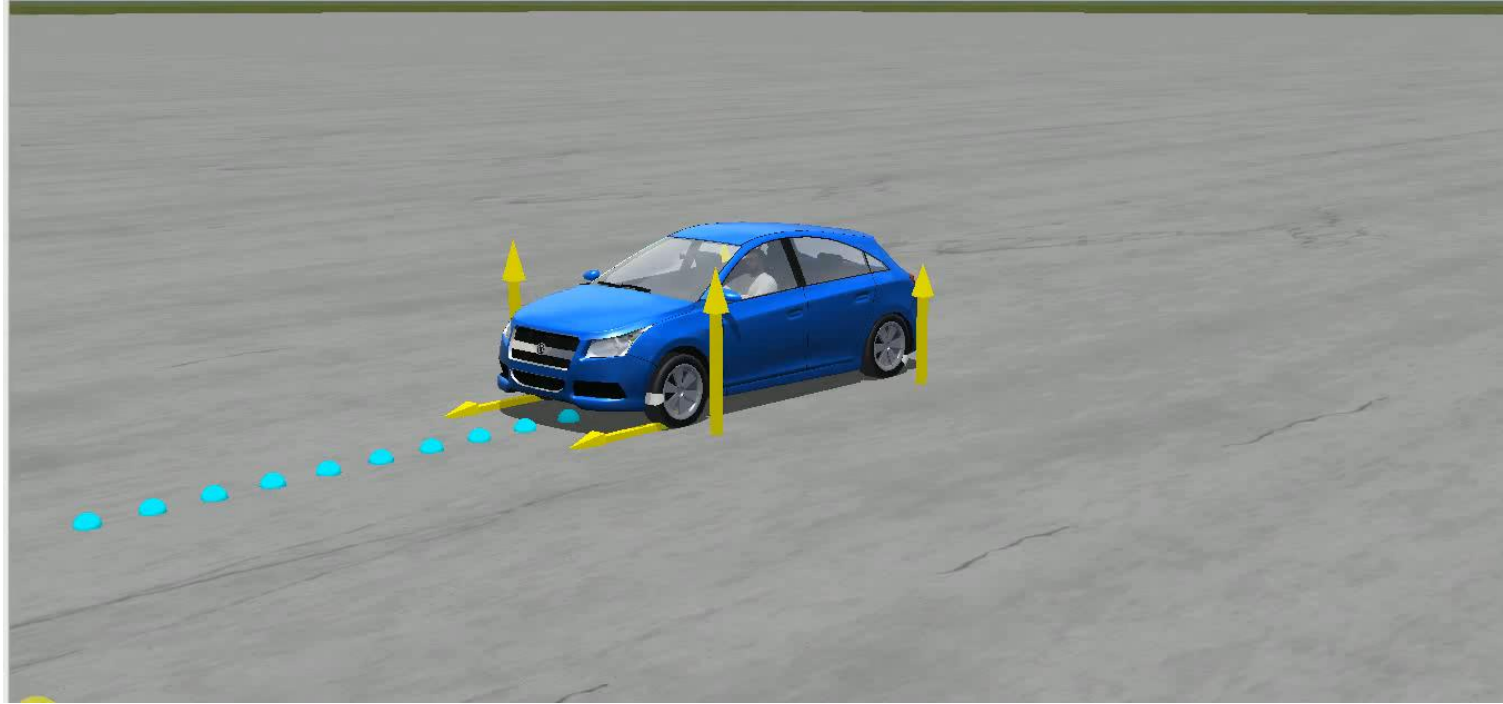


Vertical Forces - Rear : Baseline

Force - N

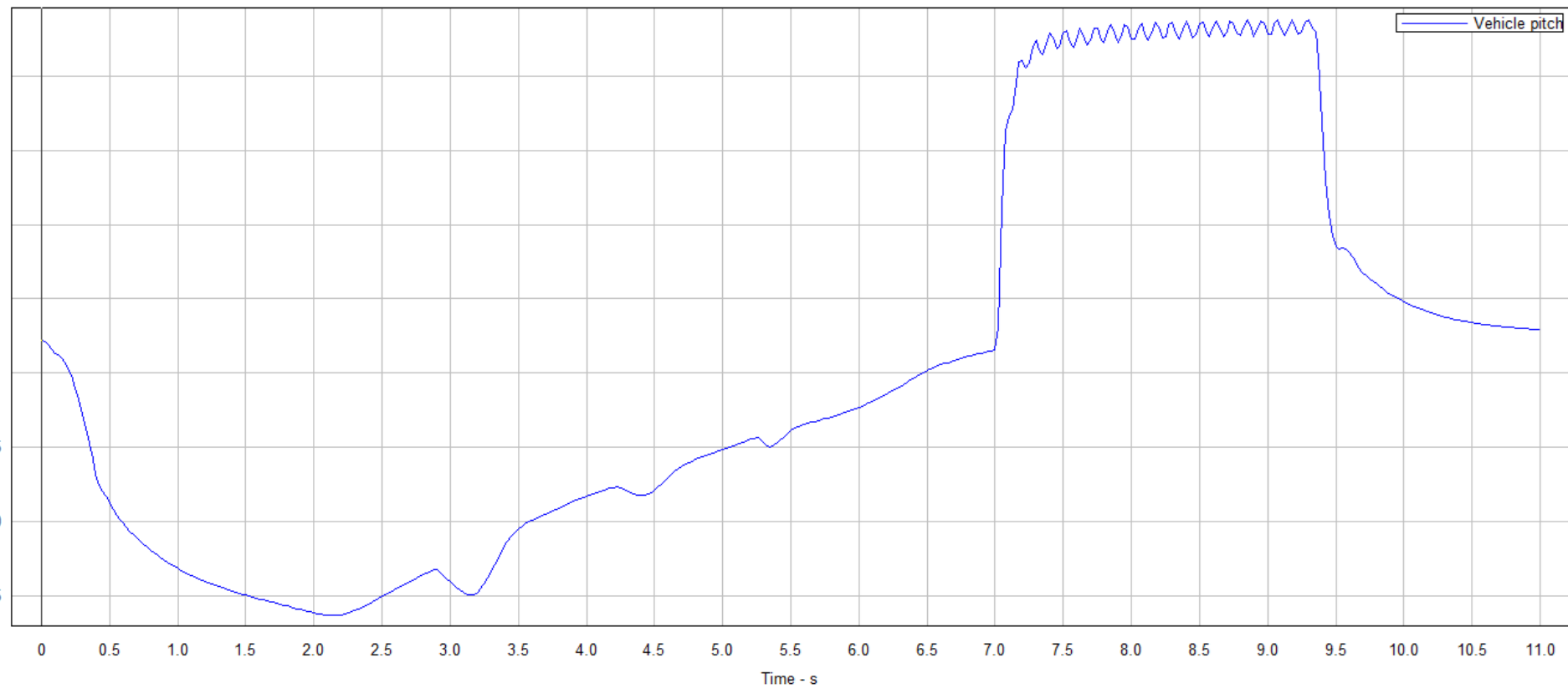


# Pitching Motion



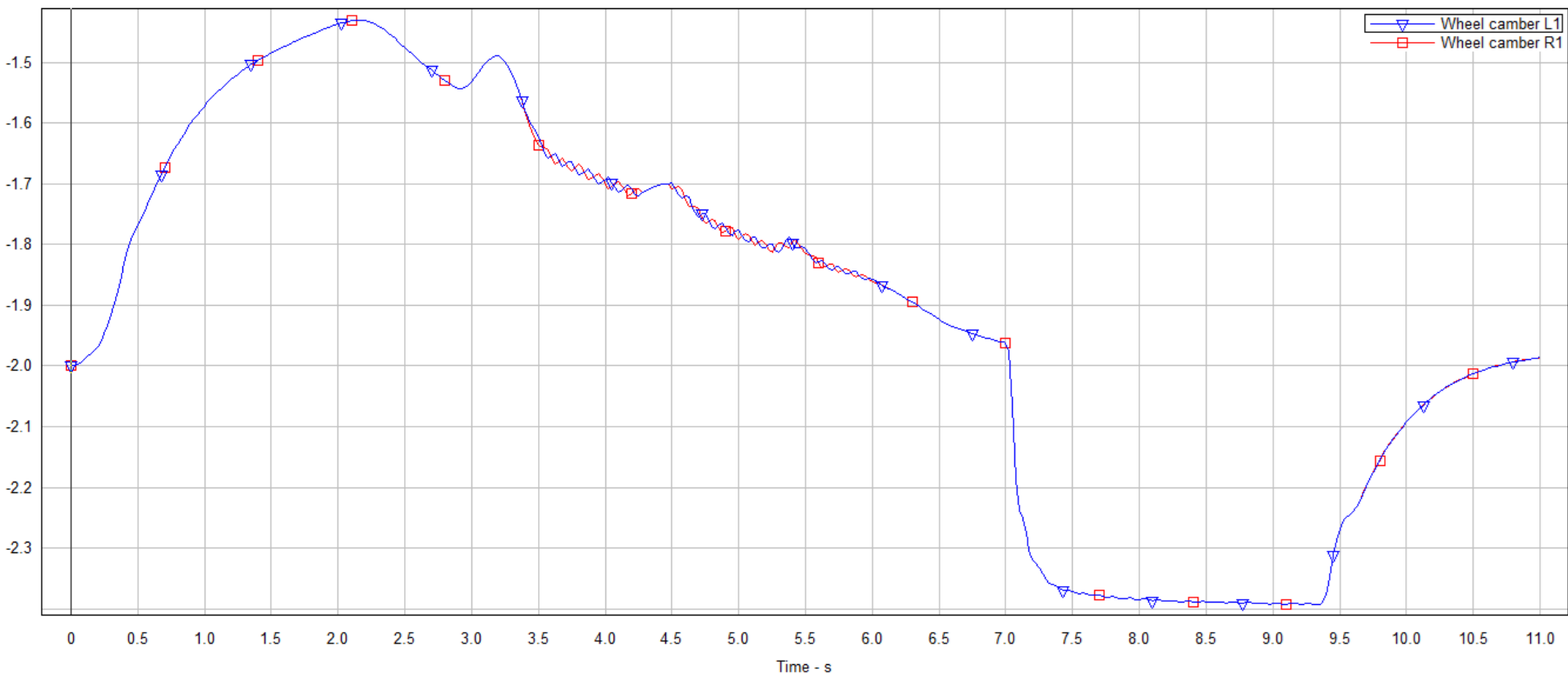
Pitch Angle of Sprung Masses : Baseline

Pitch, vehicle - deg



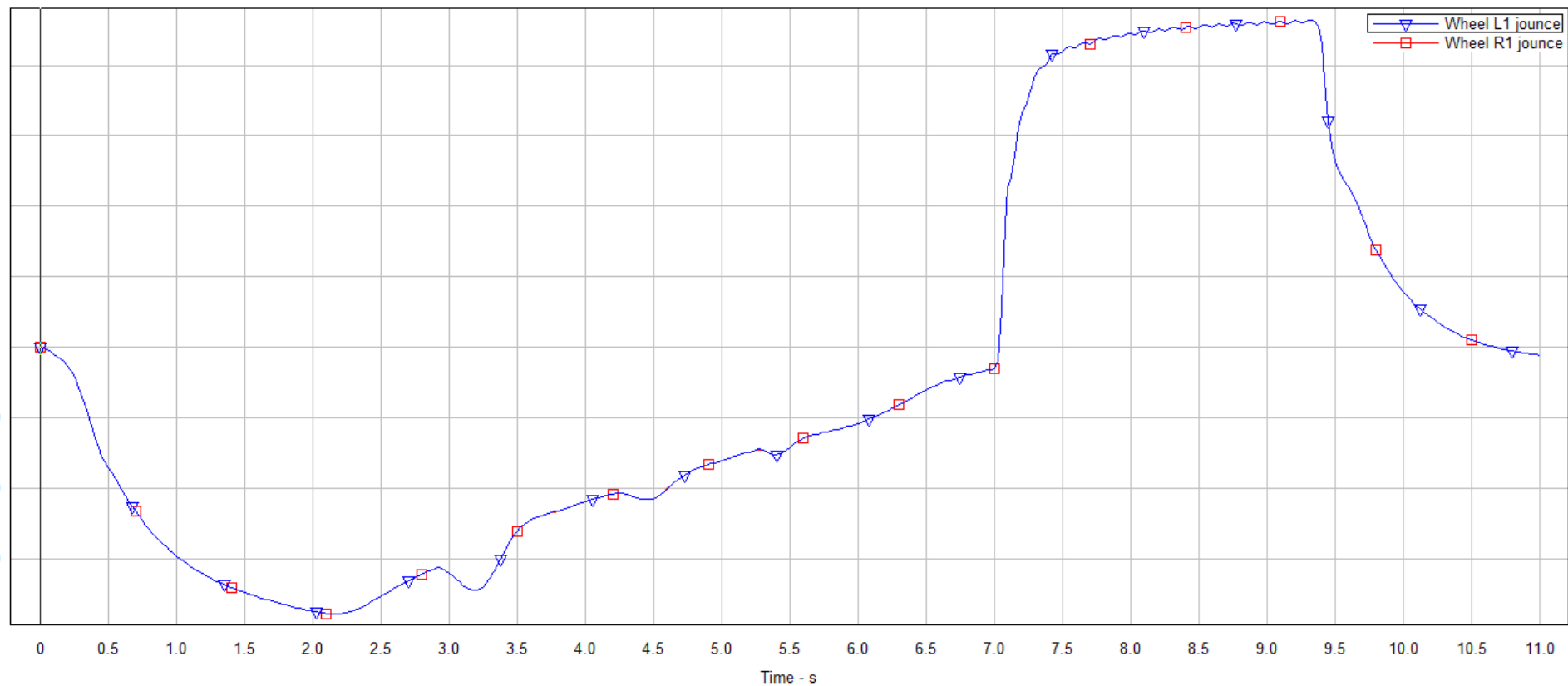
Camber - Front : Baseline

Angle - deg



Jounce - Front : Baseline

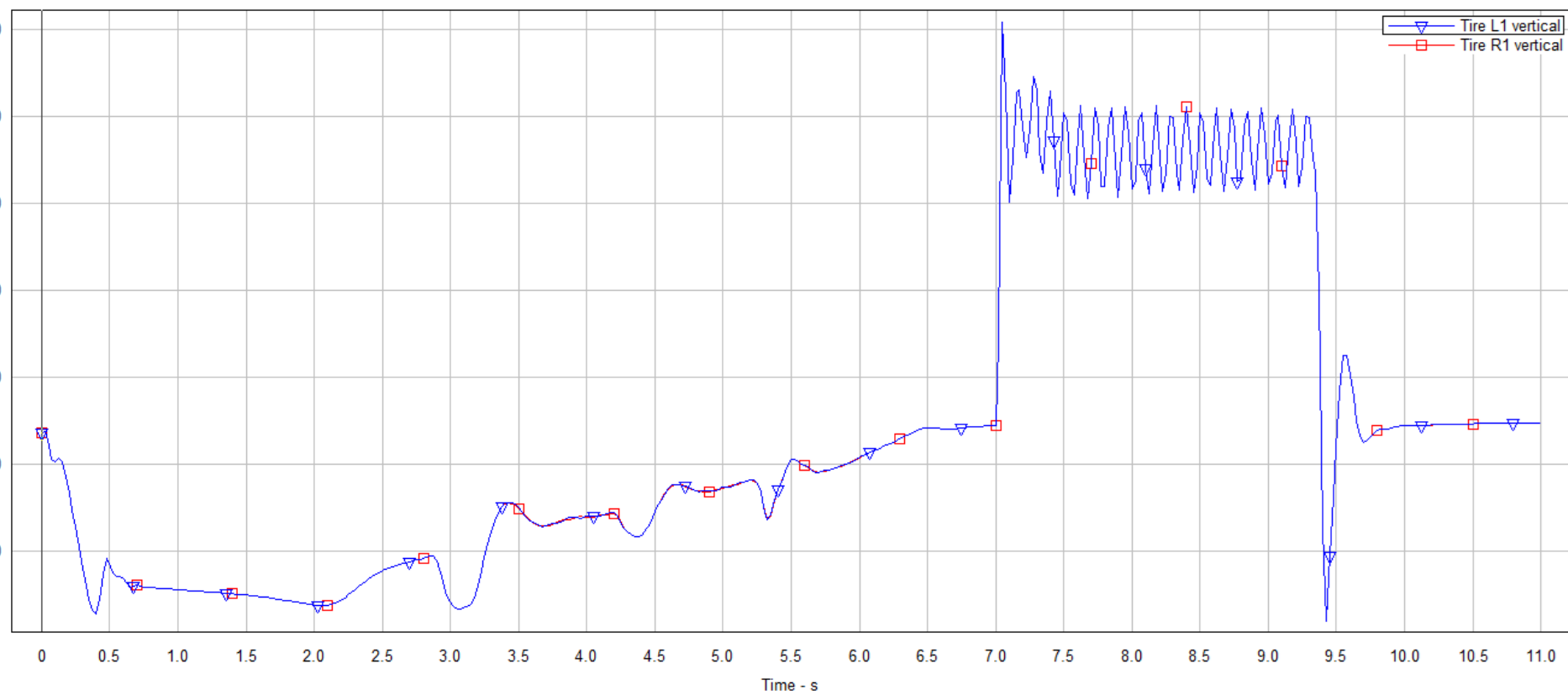
Compression - mm





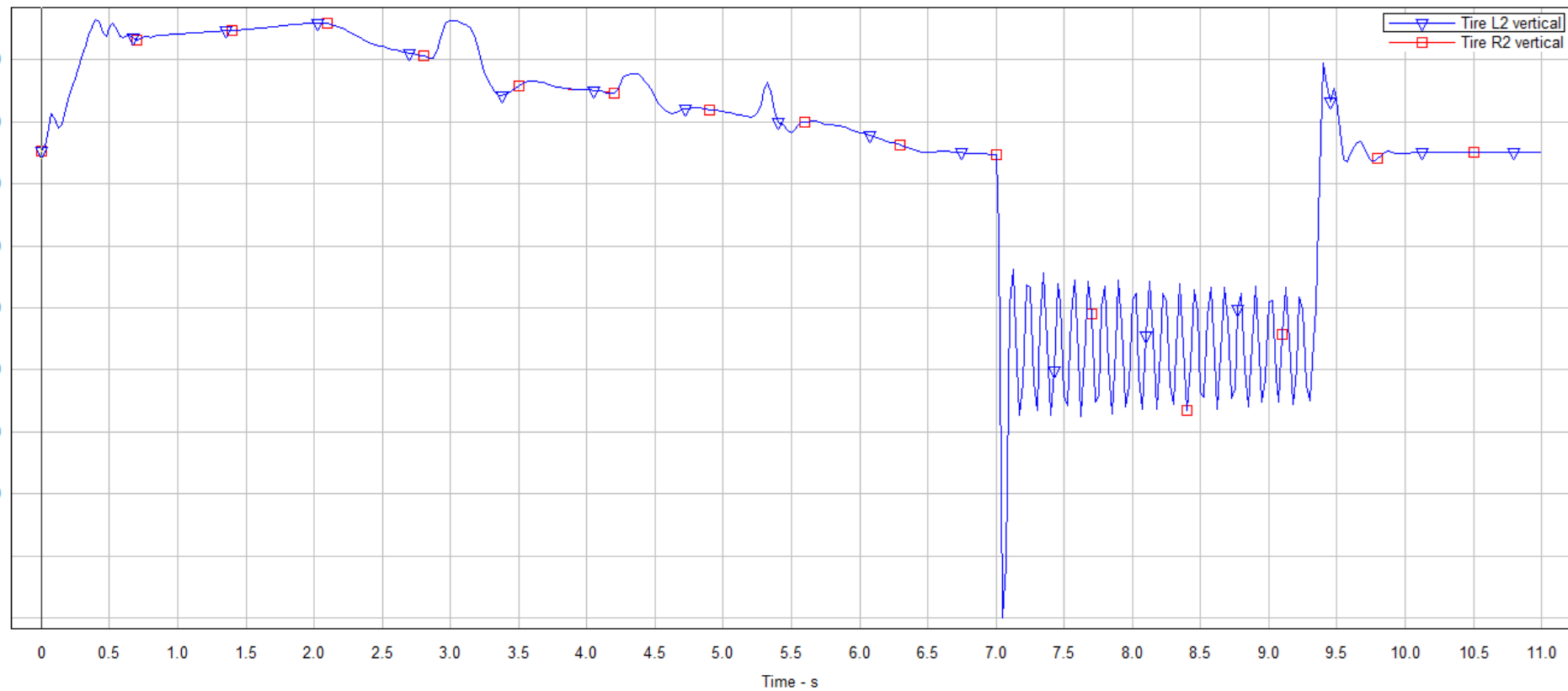
Vertical Forces - Front : Baseline

Force - N



Vertical Forces - Rear : Baseline

Force - N



# References

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Thank You.