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# Evaluation of a New Light Rail System by SIMPACK Simulation

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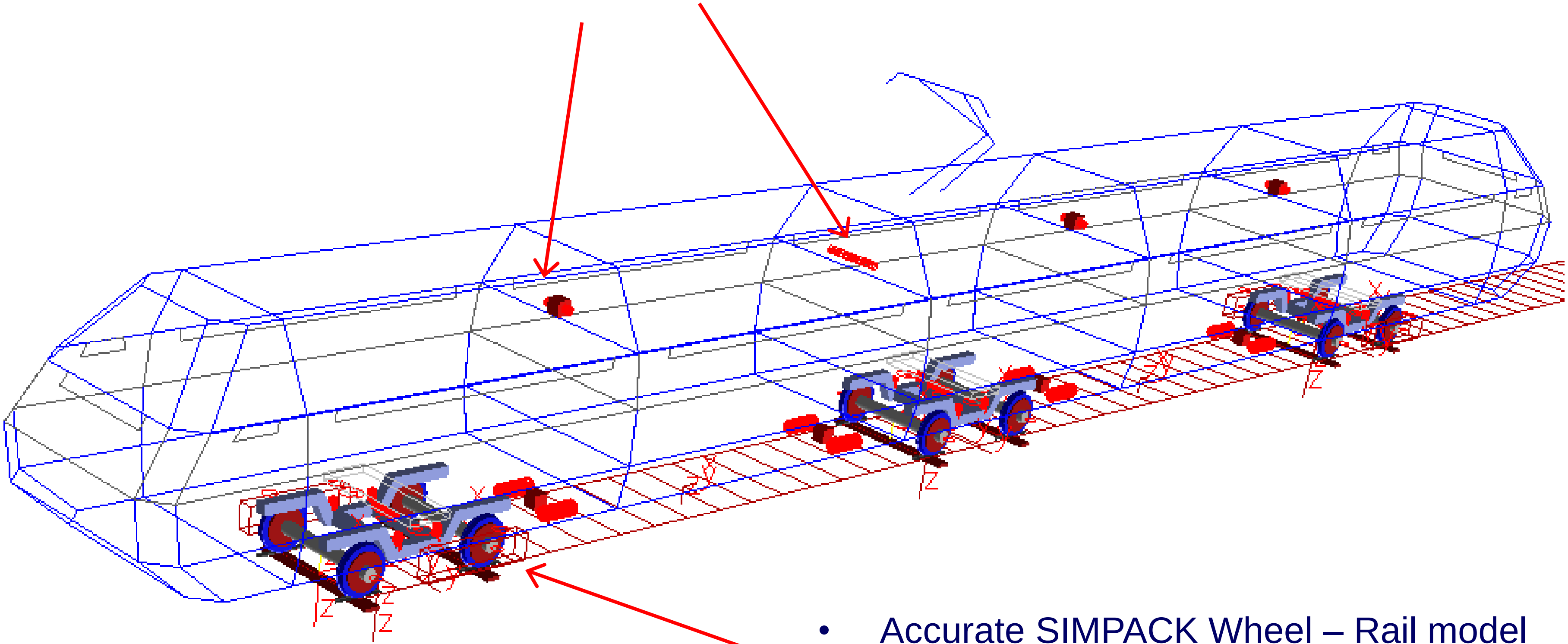
- Vehicle / track model
- Optimization of track gauge and cant based on curving performance
- Identified safety limits of speed on curved track
- Stability analysis on tangent track

# Vehicle Model

- Five modules supported by three bogies
- Different connection joints between 5 vehicle modules

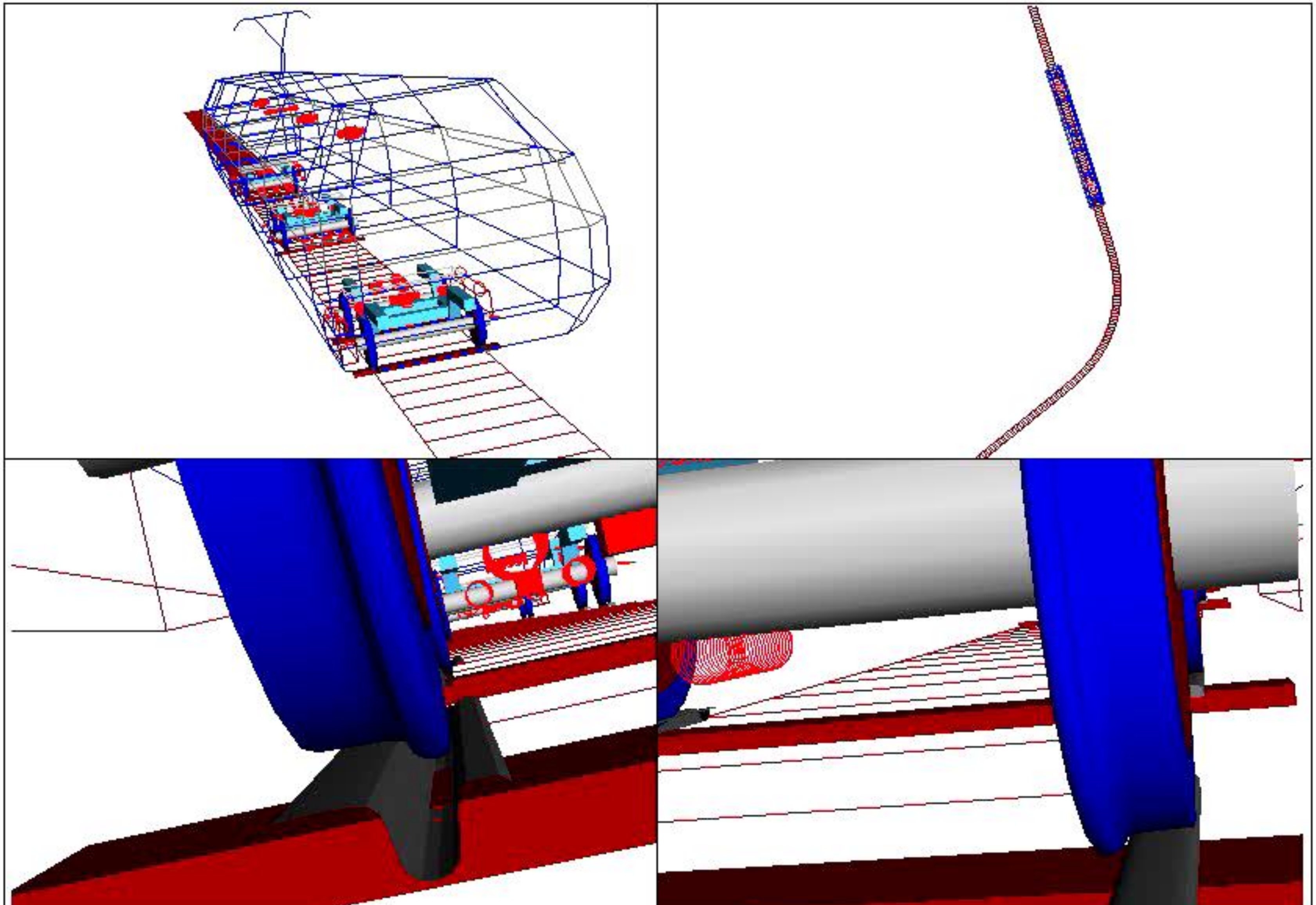


- Accurate SIMPACK Wheel – Rail model
- Considered elastic wheels effect

# Wheel and Rail

- Wheelset
  - Wheel radius 640 mm
  - Back to back dimension 1378.6 mm
  - Wheel profile designed by OEM
  - Elastic wheel
- Rail
  - Outside Re115 with 0 or 1 in 40 cant
  - Inside - girder rail
  - Gauge point 15.875 mm (5/8”) from Top of Rail
  - Standard gauge 1435.1 mm (56.5”)
  - Gauge on curves to be determined
- Wheel – Rail interface friction 0.5

# Animation



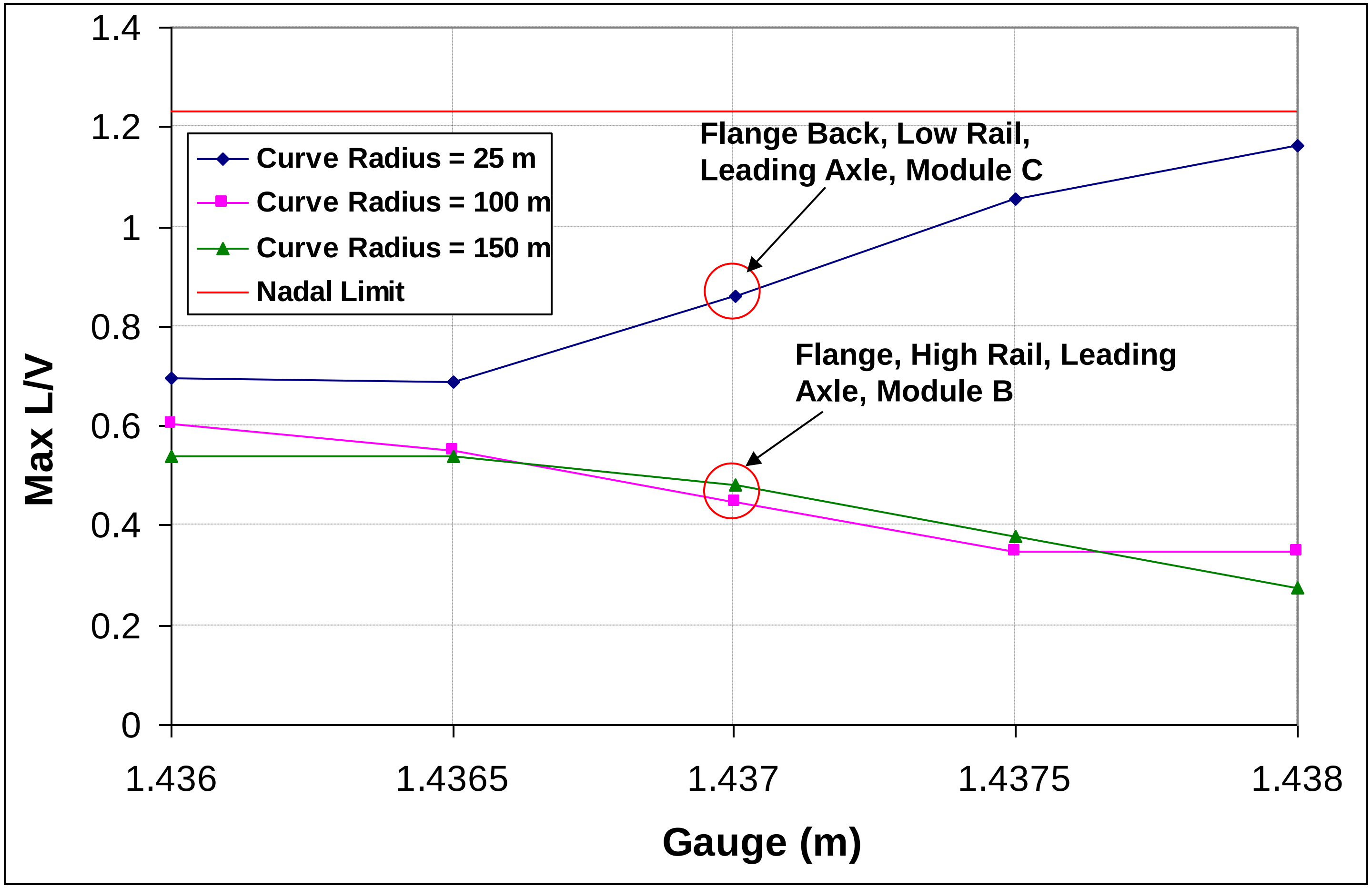
# Track Model

- Curving analysis on constant curvature part of smooth track
  - Curve body radius 25 m, 100 m and 150 m
  - No perturbations

- Hunting analysis on smooth tangent track with initial lateral perturbation
  - Lateral bump peak to peak = 15 mm

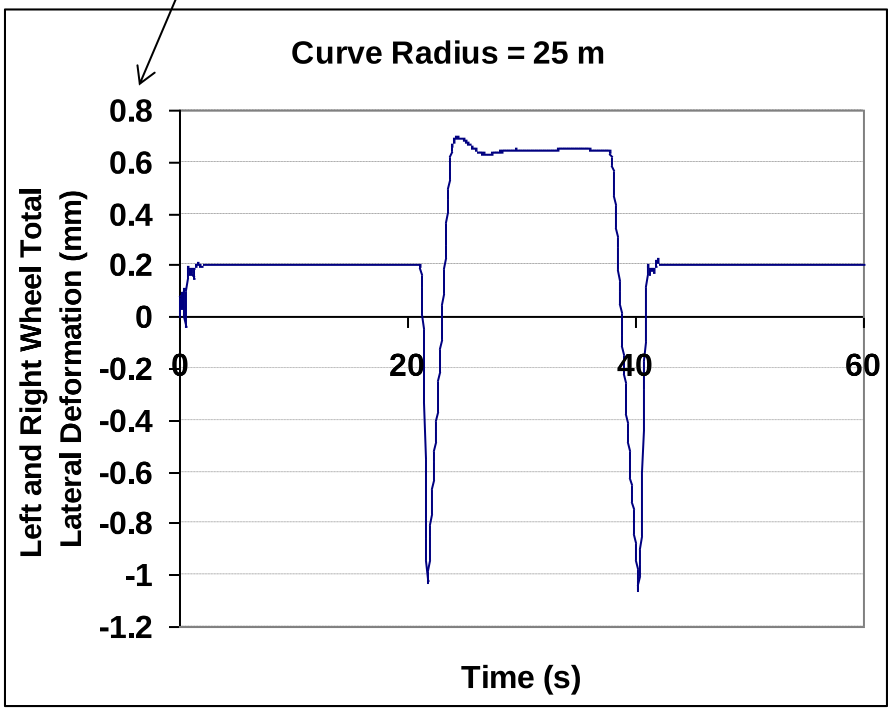
# Gauge Optimization

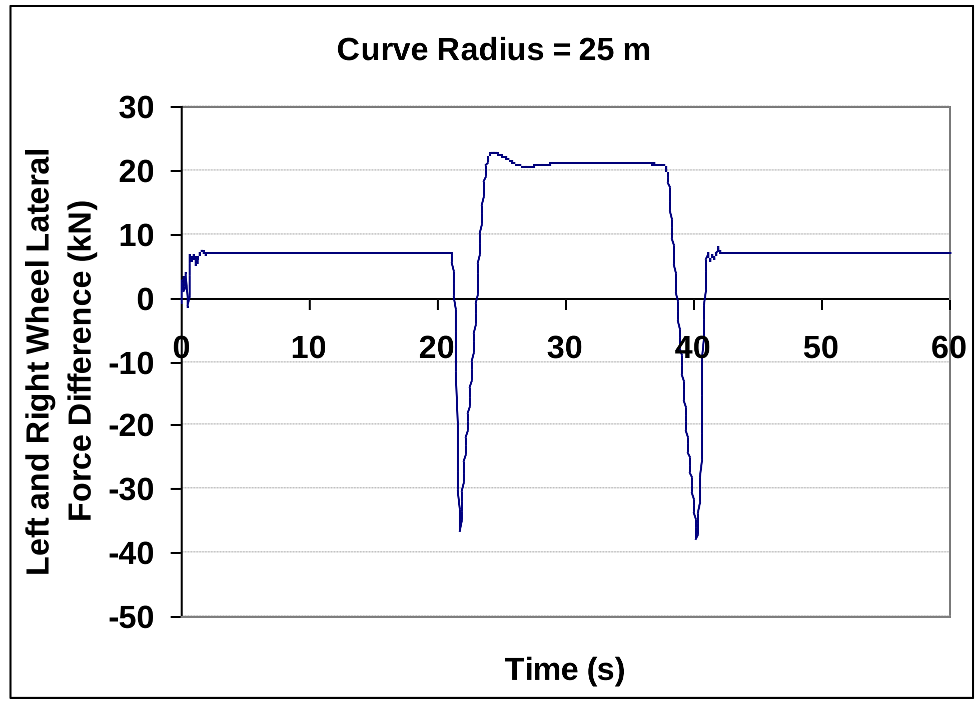
# Maximum L/V vs. Gauge (R = 25, 100 and 150 m)



# Effect of Elastic Wheel on Back to Back Spacing

Lateral wheel deformation = Increase of back to back spacing
("+" as increase and "-" as decrease of back to back spacing)

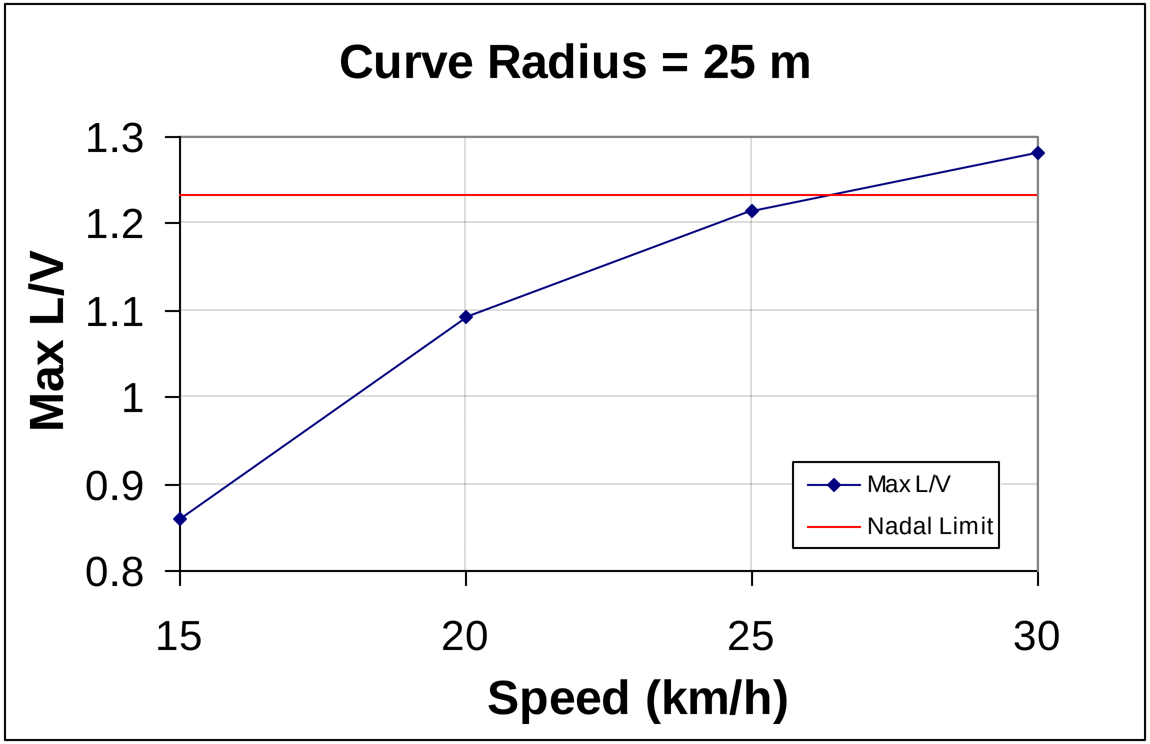


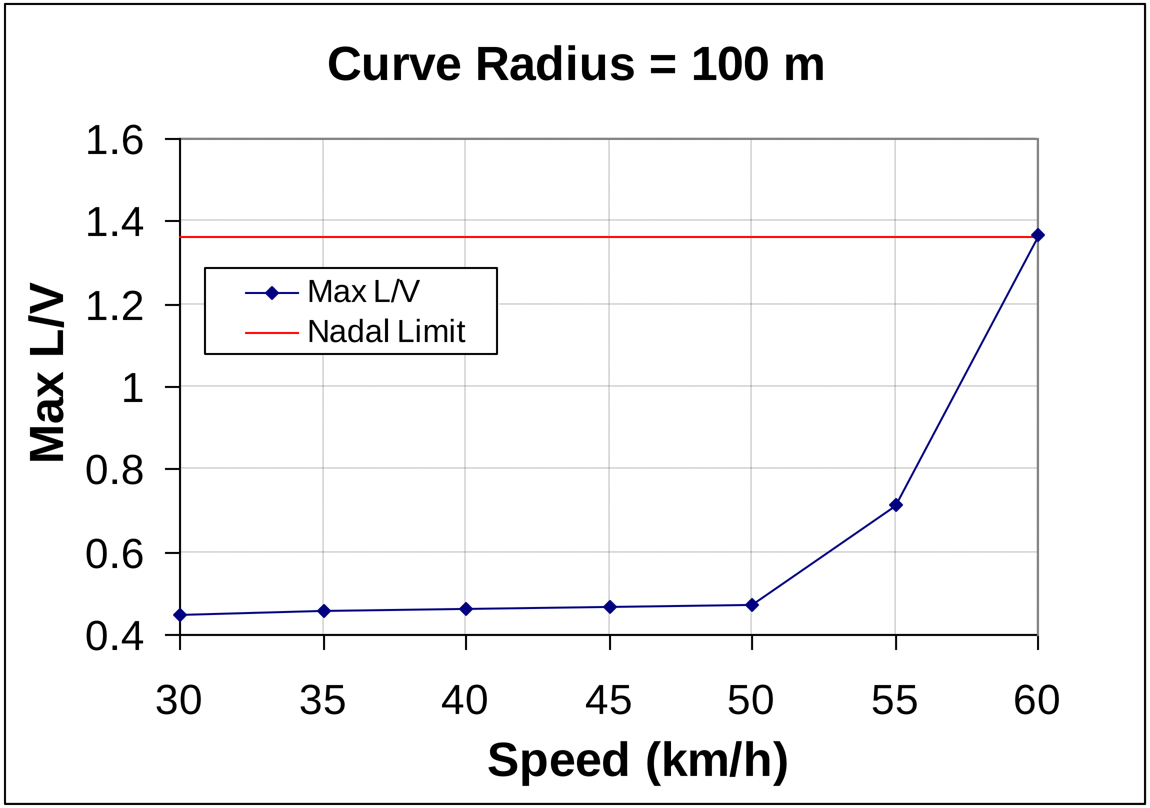

Lateral Wheel Deformation and Forces, Leading Axle,
Module C (R = 25 m, Speed = 15 km/h, Gauge = 1.437 m)

# Safety Limit of Speed

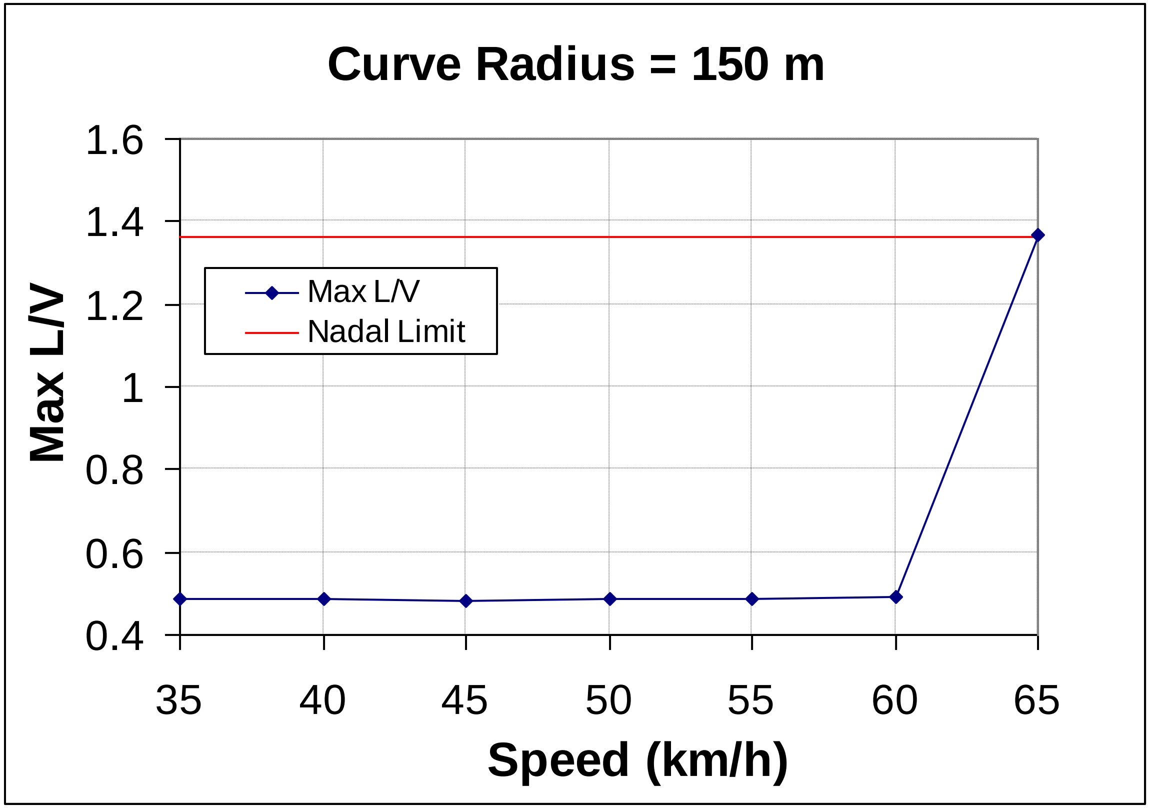
# Maximum L/V vs. Speed (R=25m, Gauge = 1.437 m, Wheel - Rail Friction = 0.5)



# Maximum L/V vs. Speed (R=100m, Gauge = 1.437 m)

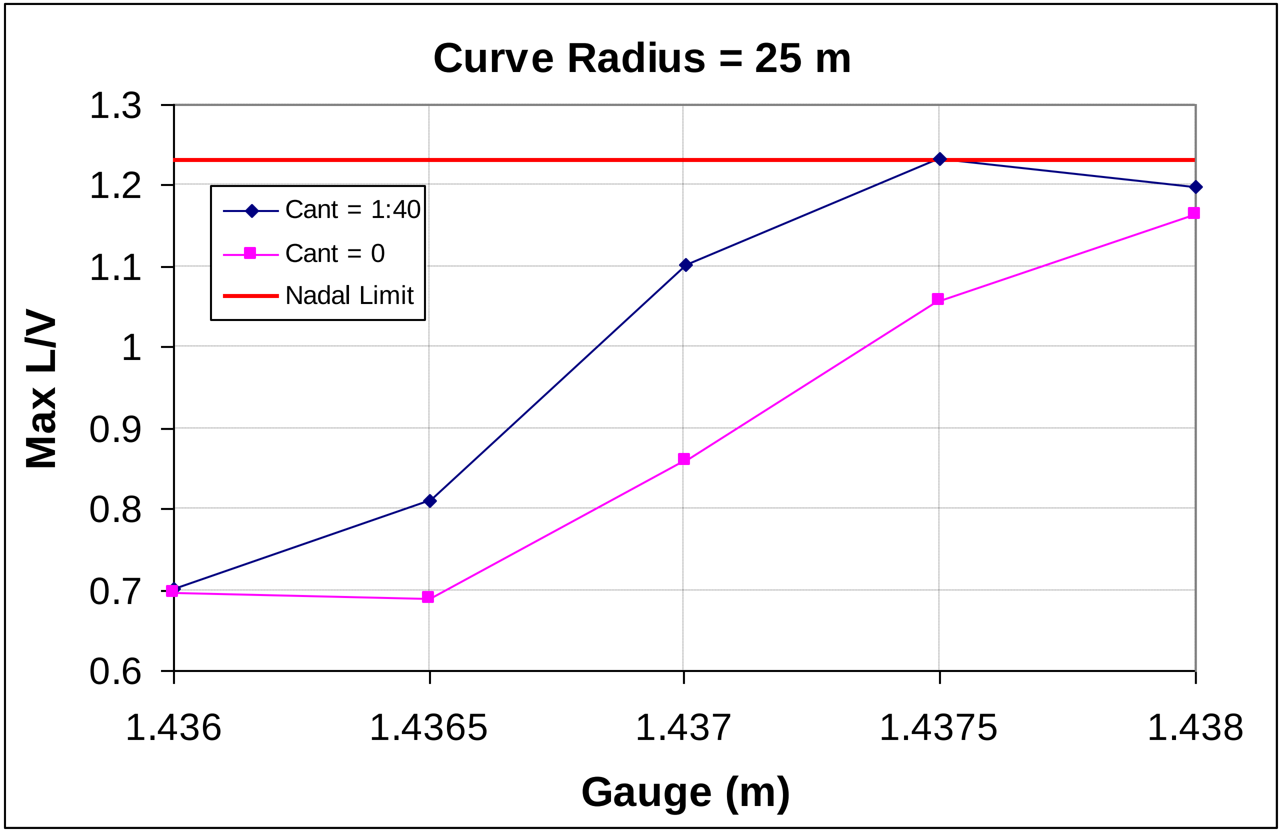


# Maximum L/V vs. Speed (R=150m, Gauge = 1.437 m)



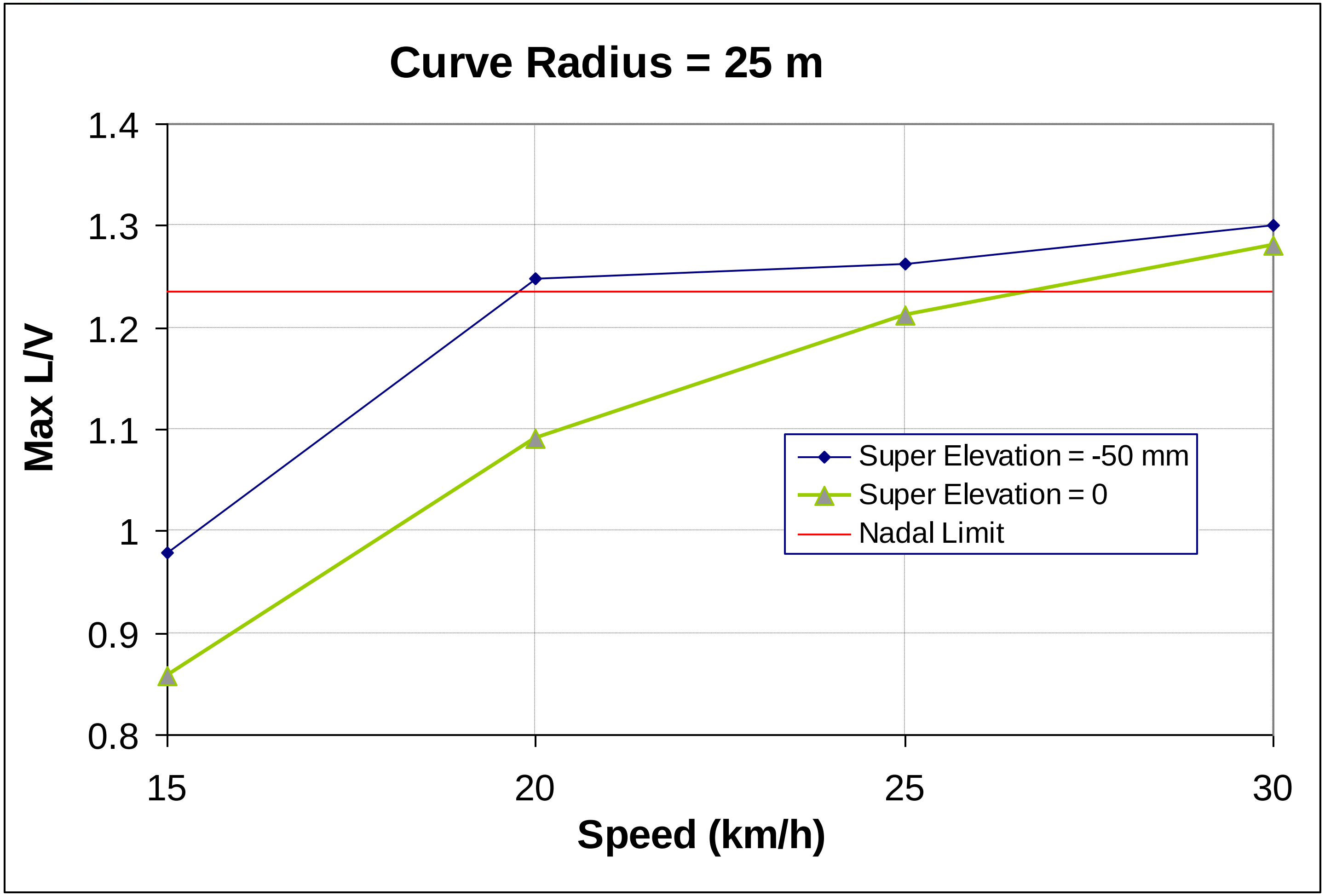
# Cant Effect

# Maximum L/V vs. Gauge (R=25m, V = 15 km/h, Cant = 0 and 1:40)

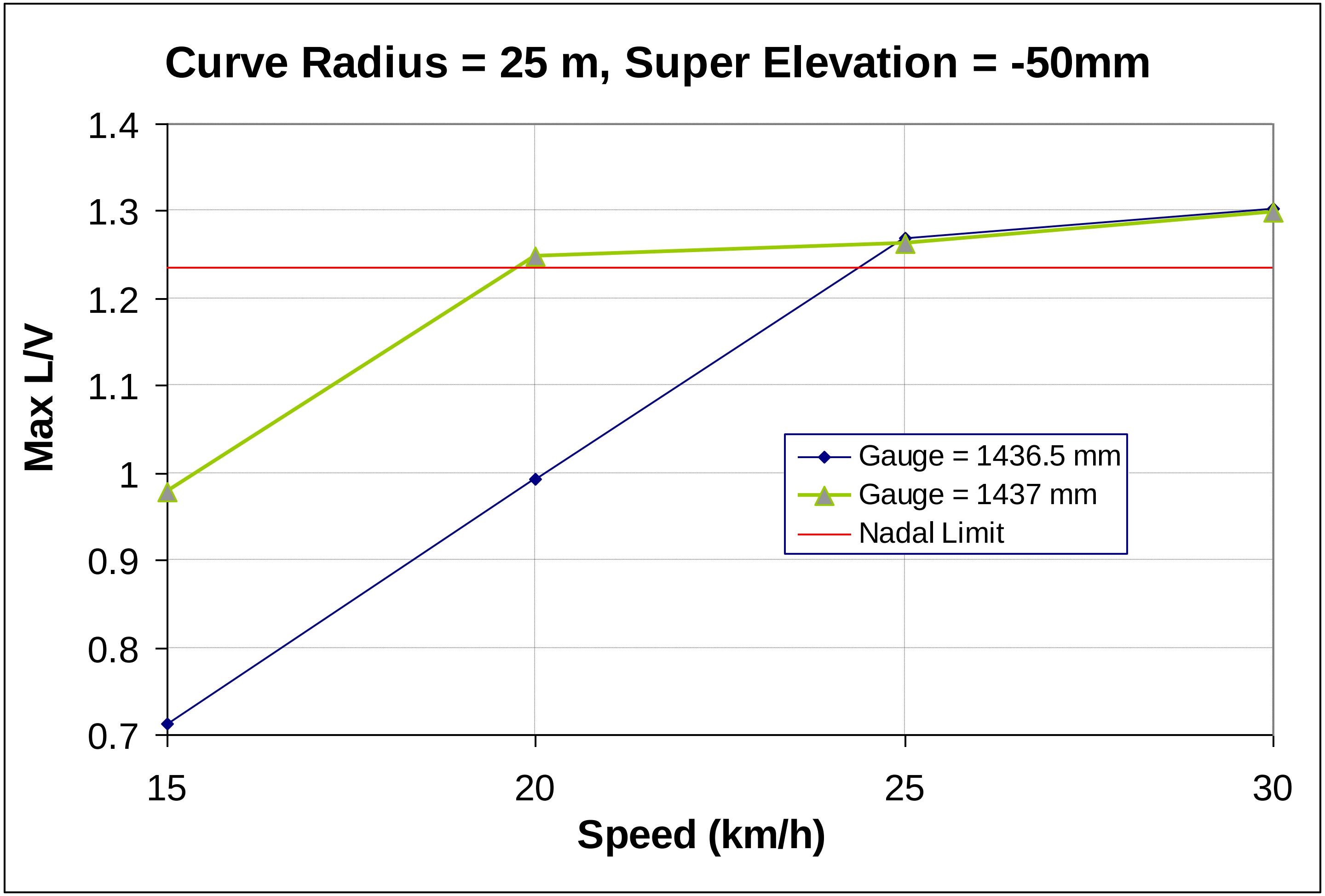


# Superelevation Effect

# Maximum L/V vs. Speed (R=25m, Gauge = 1.437 m, SuperElevation = - 50 mm)

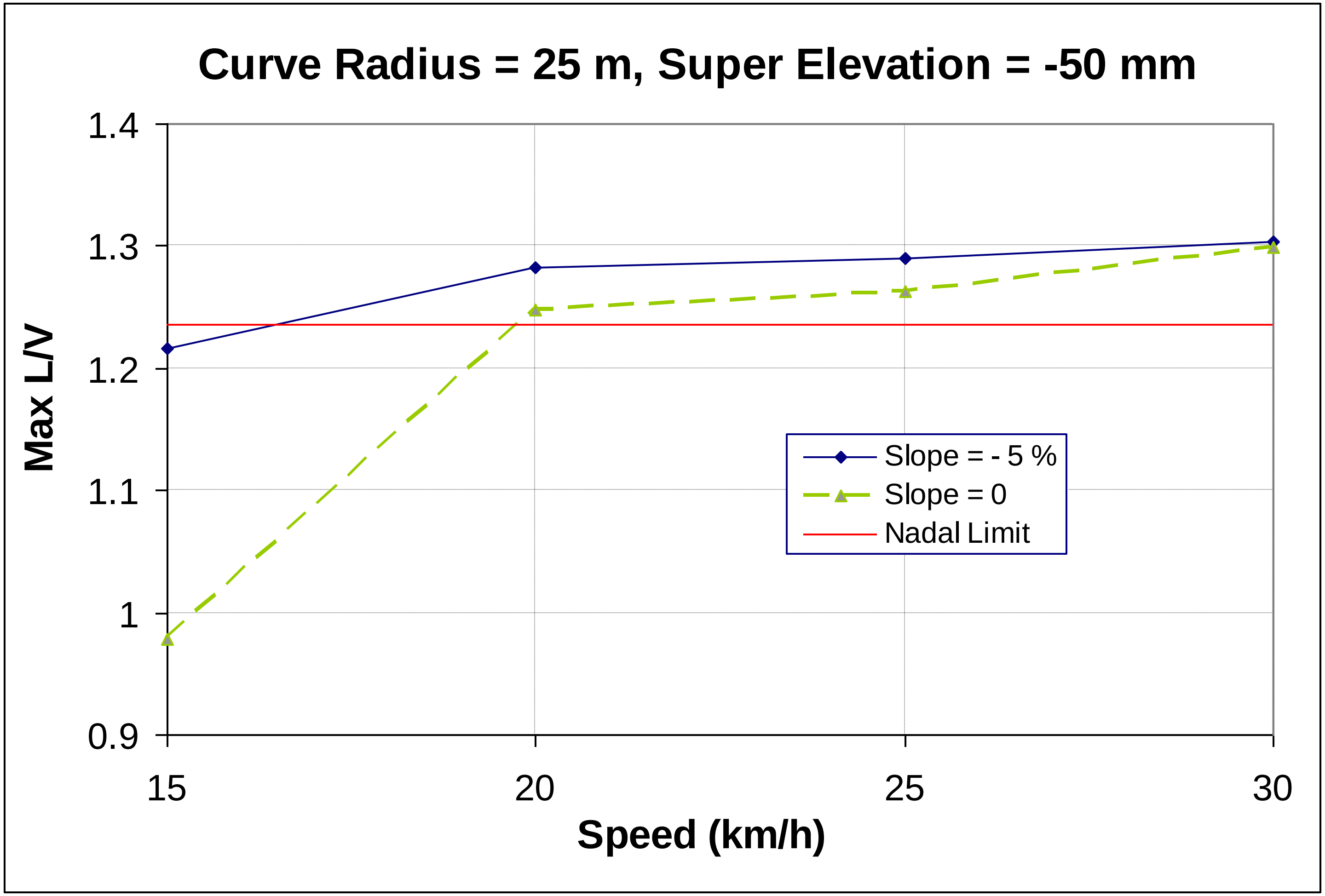


# Maximum L/V vs. Speed (R=25m, Superelevation = -50mm, Gauge = 1436.5 mm and 1437 mm)

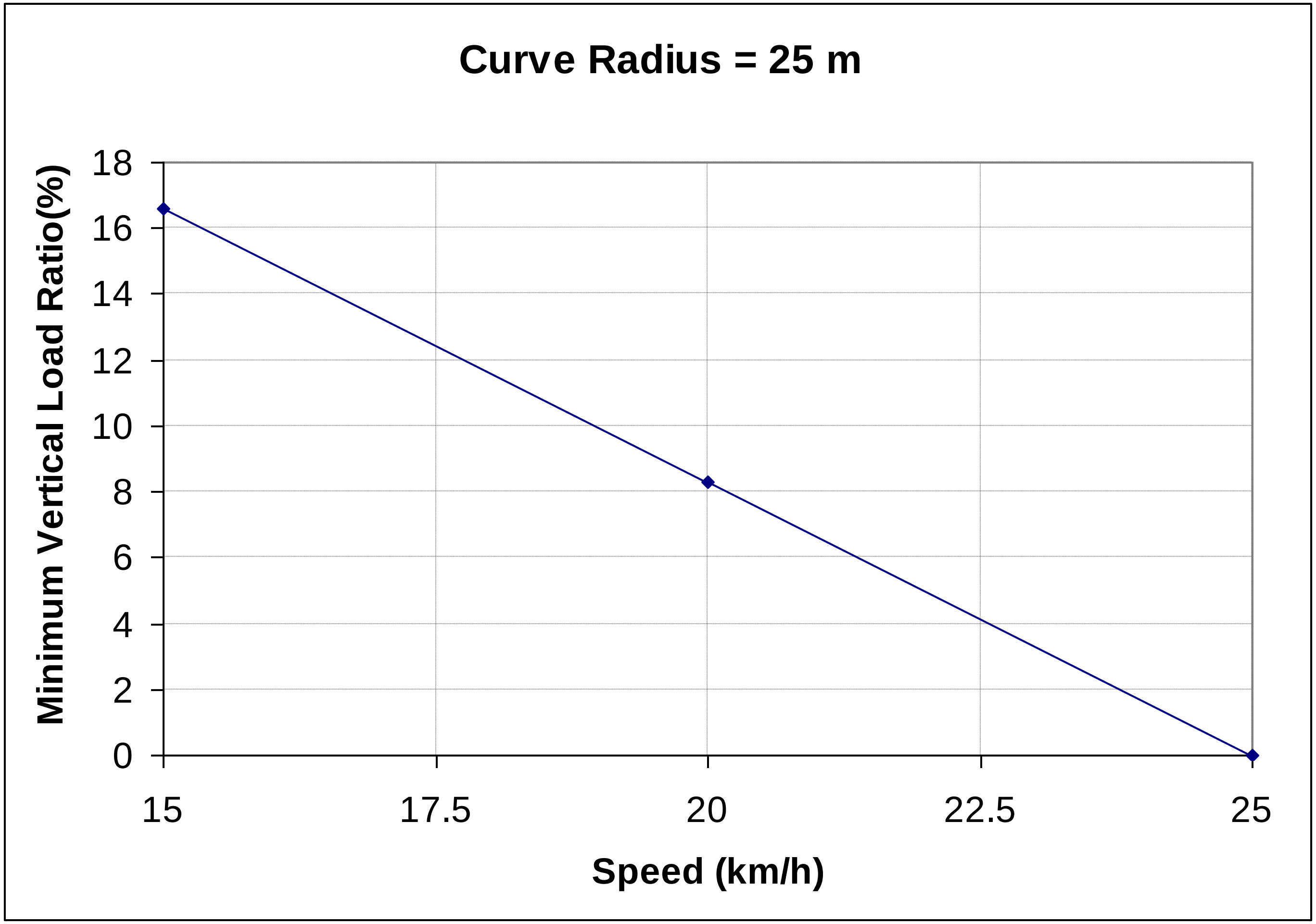


# Grade Effect

# Maximum L/V vs. Speed (R=25m, Gauge = 1.437 m, Super Elevation = -50mm, Grade = 0 and -5 %)

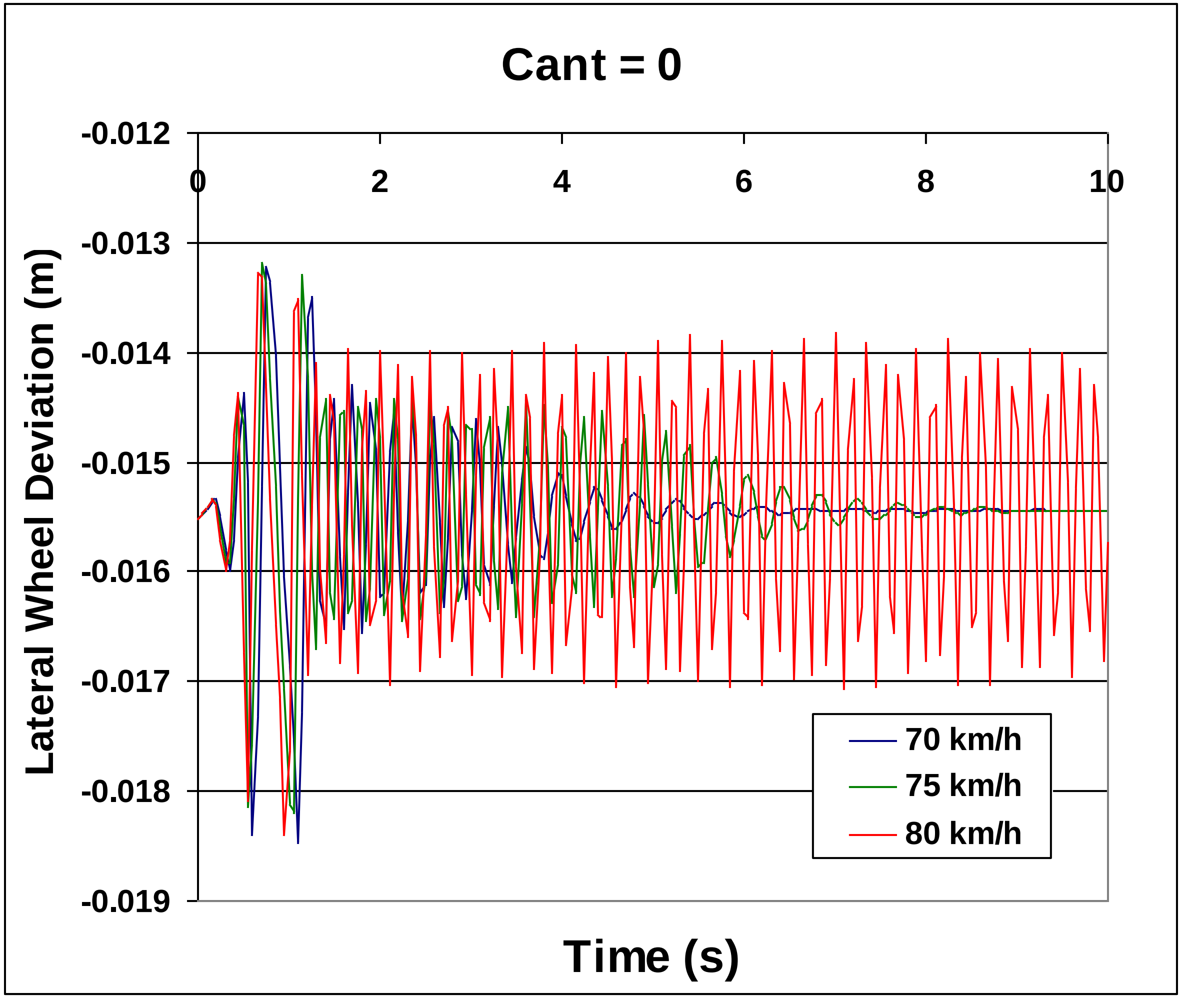


# Minimum Vertical Load Ratio vs. Speed (R=25m, Gauge = 1.437 m, Super Elevation = -50mm, Grade = -5 %)

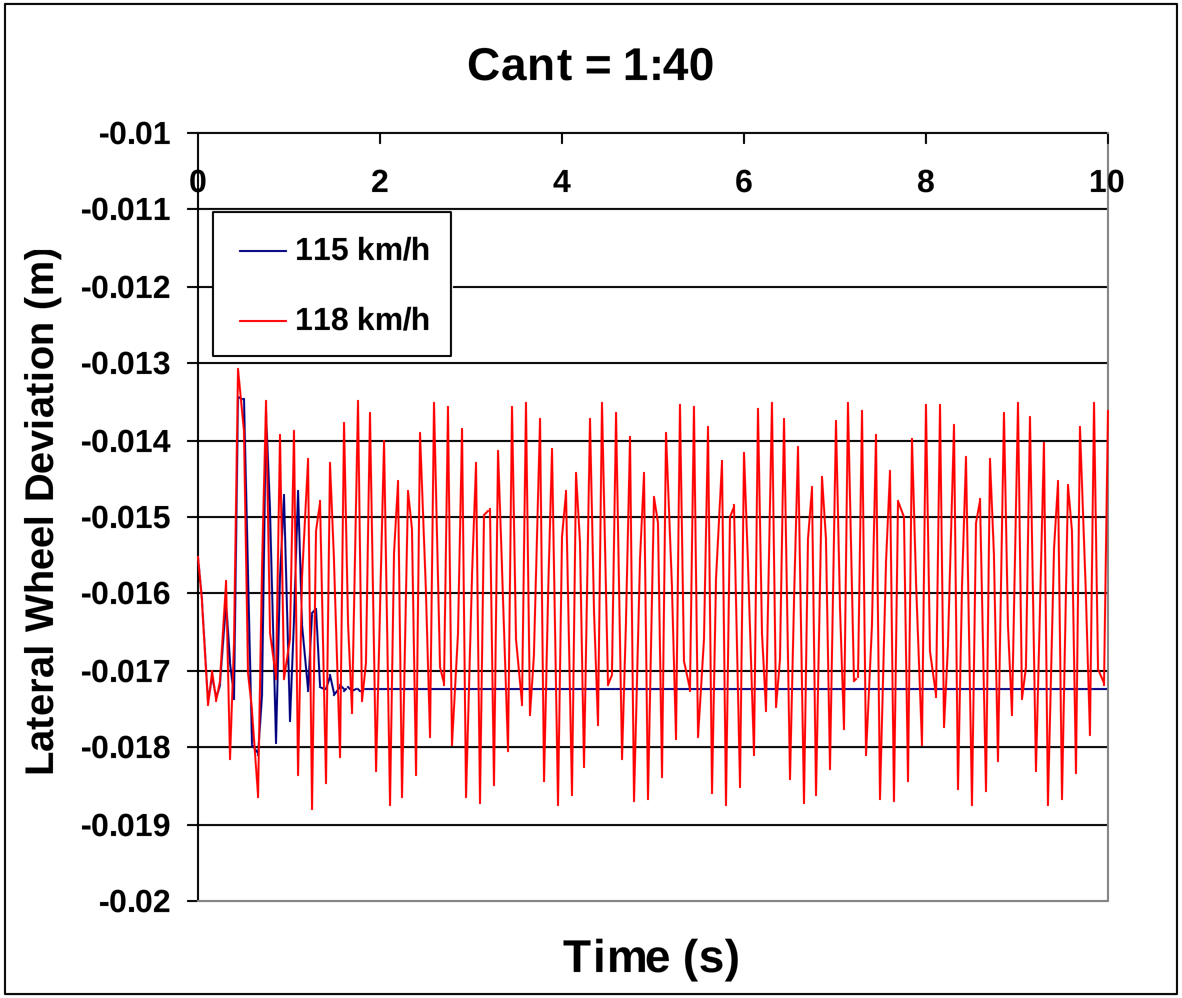


# Maximum Speed on Tangent Track

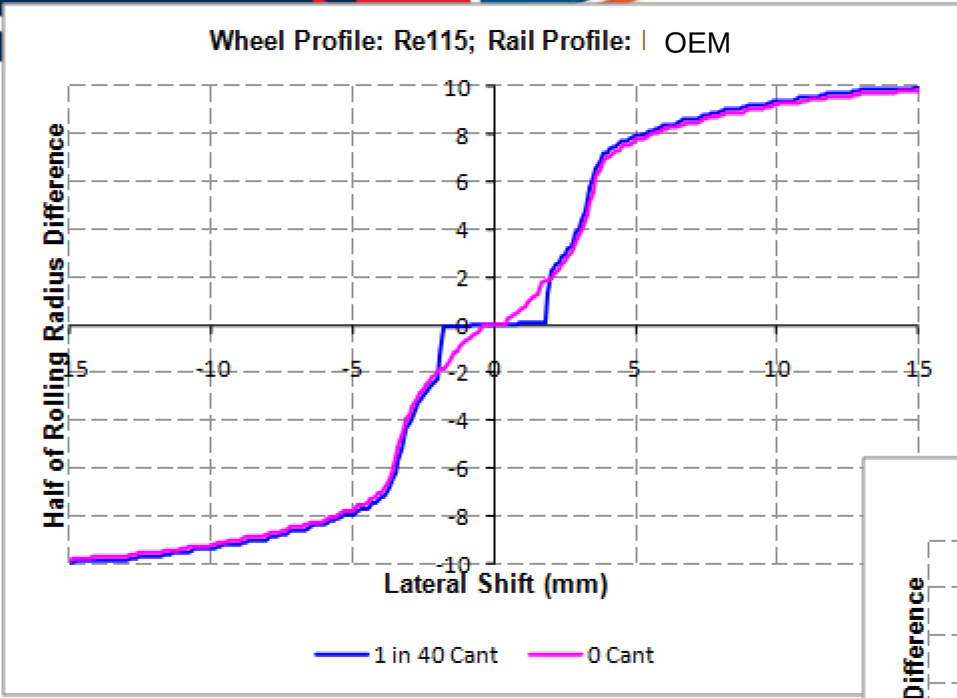
# Wheel Lateral Displacement vs. Time (Tangent Smooth Track, Gauge = 1.437 m, Cant = 0 )

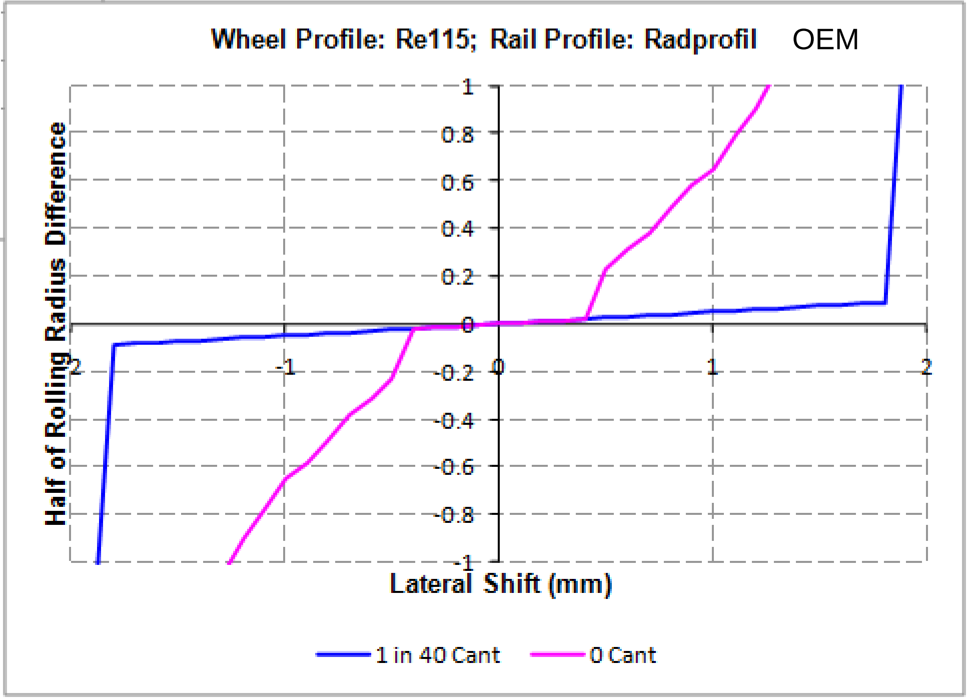


# Wheel Lateral Displacement vs. Time (Tangent Smooth Track, Gauge = 1.437 m, Cant = 1:40)



# Conicity, 0 and 1/40 Cant



# Conclusion about Gauge

- To achieve the best load sharing effects of girder rail, sharp curve requires a gauge narrower than shallow curve
  - This is because the sharper curves generate larger angle of attack, resulting in larger flange back fattening and therefore making the “effective” wheel back to back dimension narrower than the shallower curves

- Recommended gauges from dynamic simulation for different curves are
  - 1436.5 mm for curve radius between 25 m and 100 m
  - 1438 mm for curve radius between 100 m and 150 m

- However 1437 mm gauge can be a good compromise for all curves between 25 m to 150 m, assuming 0 cant on these curves and no negative superelevation

# Conclusion about Cant

- Wheel profile was designed for 0 cant. Dynamic simulation results support that the better curving performance can be achieved with zero cant than 1/40 cant on curve with the girder rail section (curve radius between 25 m and 150 m)

- On tangent track with Re115 rail section, the present study found that 0 cant will move the wheel - rail contact point toward to gauge corner and result in a high conicity. Dynamic simulation shows that the critical hunting speed is 70 kph for 0 cant and 115 kph for 1/40 cant

- Therefore based on the present analysis it is preferred
    - Zero cant on curves with radius between 25 m and 150 m
    - 1/40 cant on tangent track

# Conclusion about Speed

- The maximum operation speeds on curves recommended by OEM are based on 100 mm (4 inch) cant deficiency, i.e.
  - 15 kph for 25 m radius curve
  - 29 kph for 100 m curve
  - 36 kph for 150 m curve

- Simulation shows the following safety limits based on Nadal limits
  - 25 kph for 25 m radius curve
  - 60 kph for 100 m curve
  - 65 kph for 150 m curve

- Therefore the dynamic simulations indicate that the maximum operation speeds based on 100 mm cant deficiency have good safety margins.

# Other Findings

- Negative superelavation has a considerable impact to safety margin. The cant deficiency in the case of negative superelevation is therefore suggested to be 50 mm (2 inches).

- 5% Grade was found to have a significant impact on the curving performance.