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June 19-22, 2016 | du 19 au 22 juin 2016

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DRIVE ELECTRIC INNOVATION
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Influence of in-wheel motors on a swing-arm dynamic, evaluation of ride comfort and handling

Jean-Sébastien BREST, Yoann GIMBERT
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The logo for ALTRAN, with the word in a blue, lowercase, sans-serif font. The letters are bold and modern.



Context

alTRAN

Innovation and high-tech engineering consulting
(automotive, aerospace, telecoms, energy, ...)



alTRAN
RESEARCH

Research branch
of the group

- Projects in relation with the clients
- Develop new methods, concepts

Be a step ahead and foresee the needs
of an industrial sector

Context

Vehicle modelling

Road modelling

Comfort

Road holding

Results

Conclusions



Context

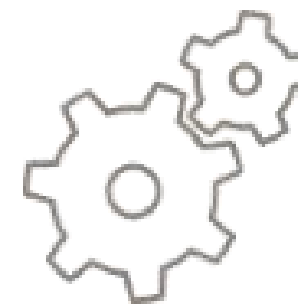
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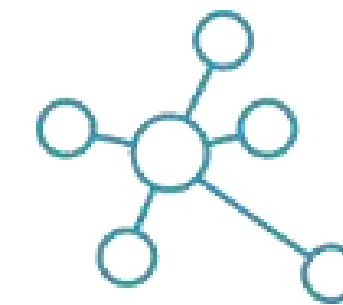


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Augmented
design



E-health



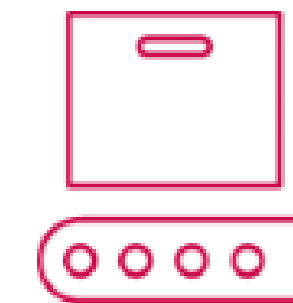
Machine-driven
big data



Connected
mobility



Smart
energies



Smart
factory

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Context

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Automotive lightweight engineering systems



Consumption simulation



Three-wheeled vehicle

Context



- Electric vehicle
- Experimental platform
- Urban mobility

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In-wheel electric motor



Protean electric



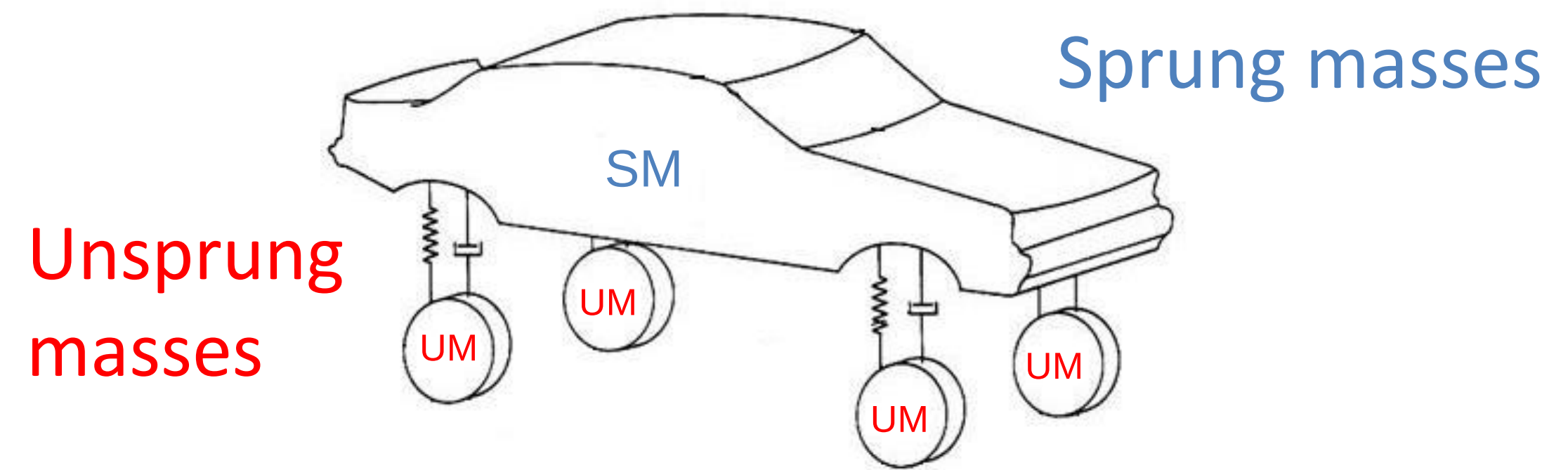
Context

Benefits:

- No transmission
- Increased space
- Lighter

Drawback:

- Increases the unsprung masses



On this type of vehicle, there are two choices for the back wheel:

- A conventional vertical system
- A swingarm

What will be its impact ?

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For the **vehicle**

For the **road**

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Vehicle modelling

Problem simplified to a 2 Dimensions model

Context

Vehicle modelling

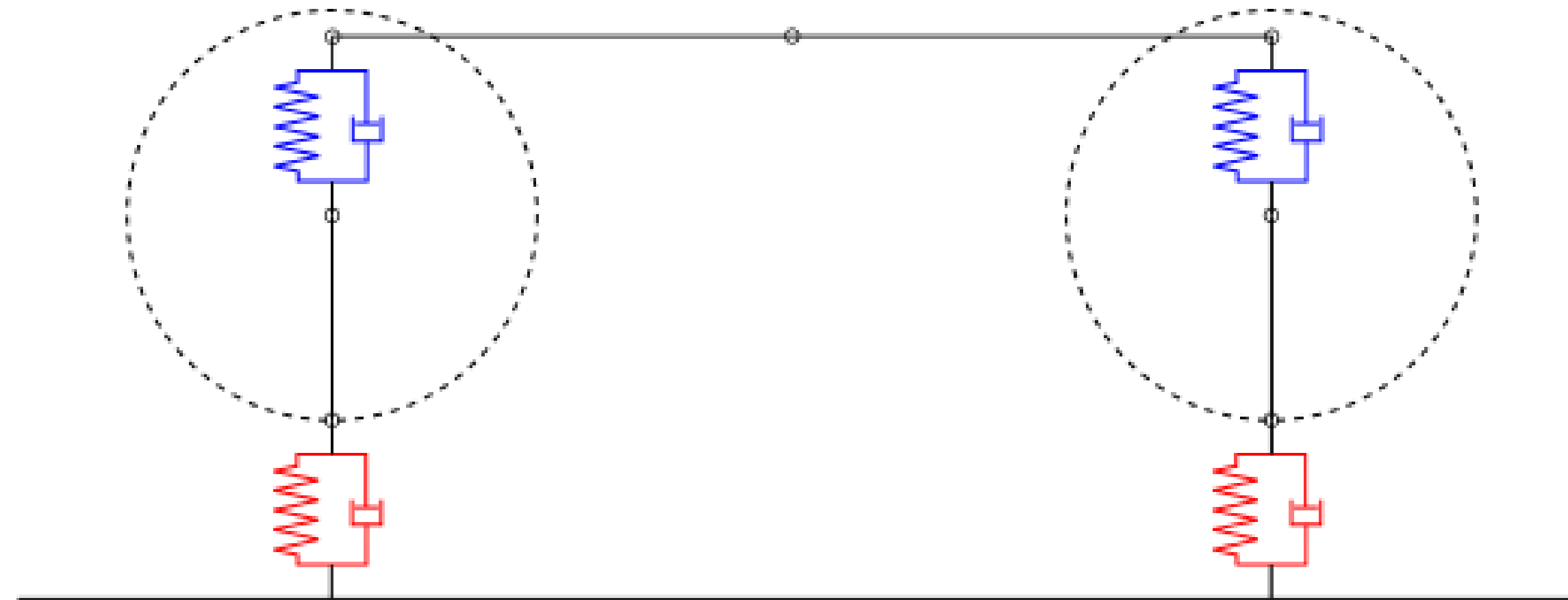
Road modelling

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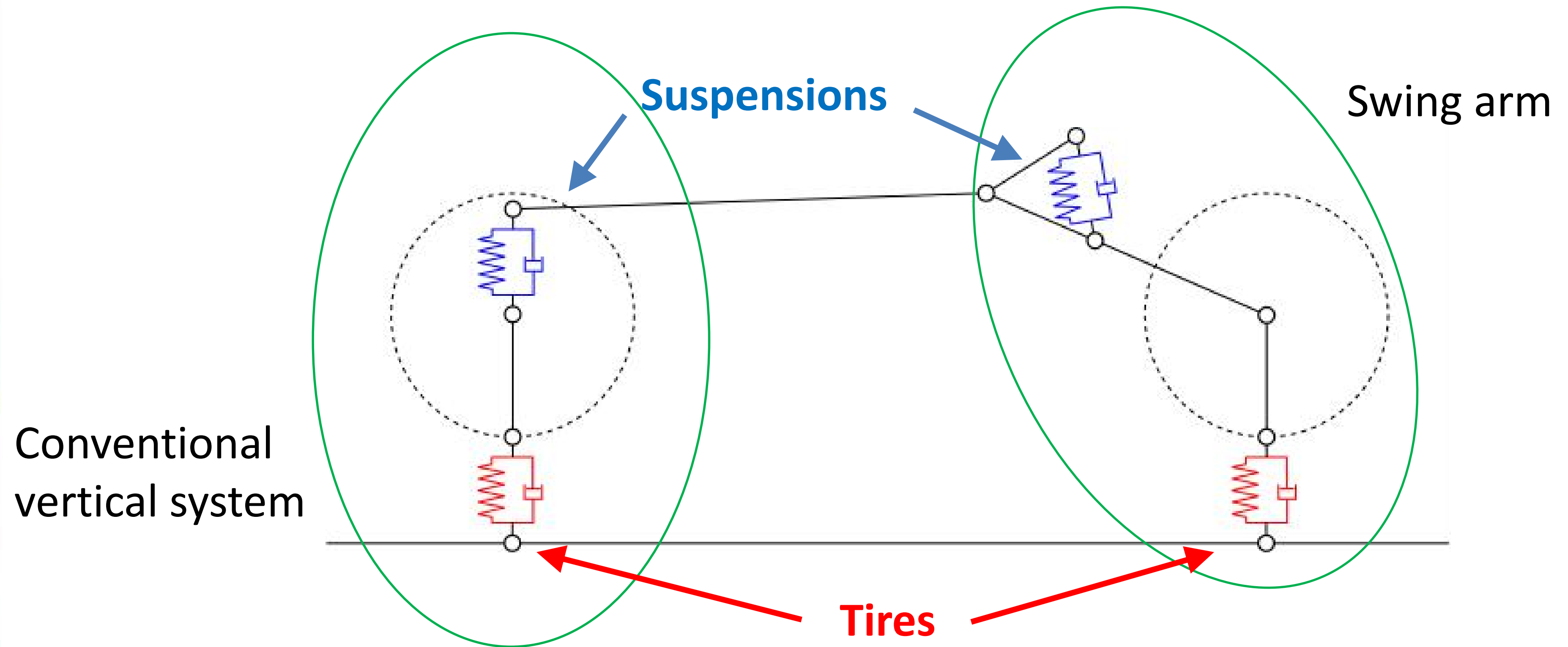
Conclusions



A couple of « conventional vertical » system
Used as a reference system for comparison

Vehicle modelling

Problem simplified to a 2 Dimensions model



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Road modelling

We also have modelled the crossing of sidewalks, **speedbumps** ...

Context

Vehicle modelling

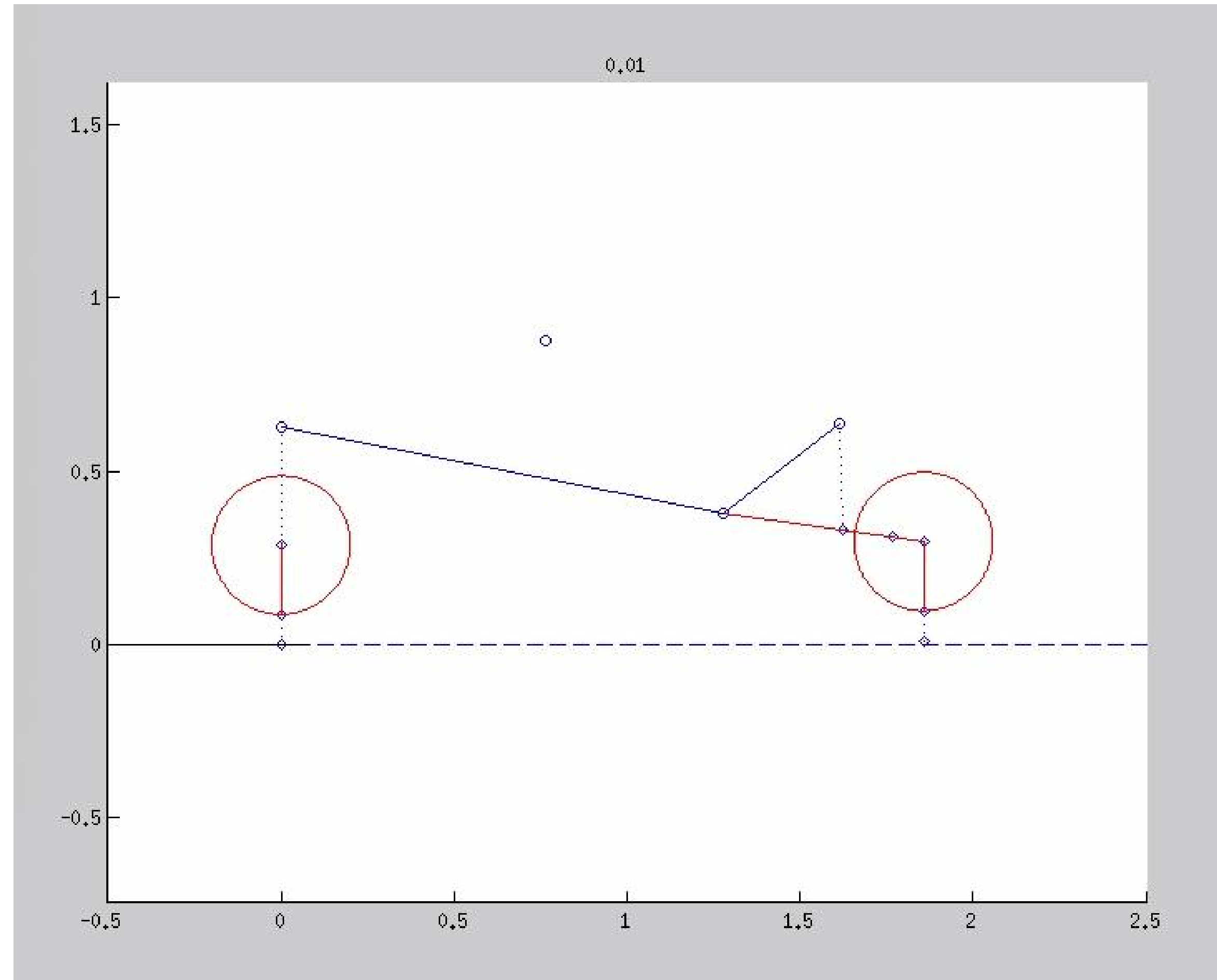
Road modelling

Comfort

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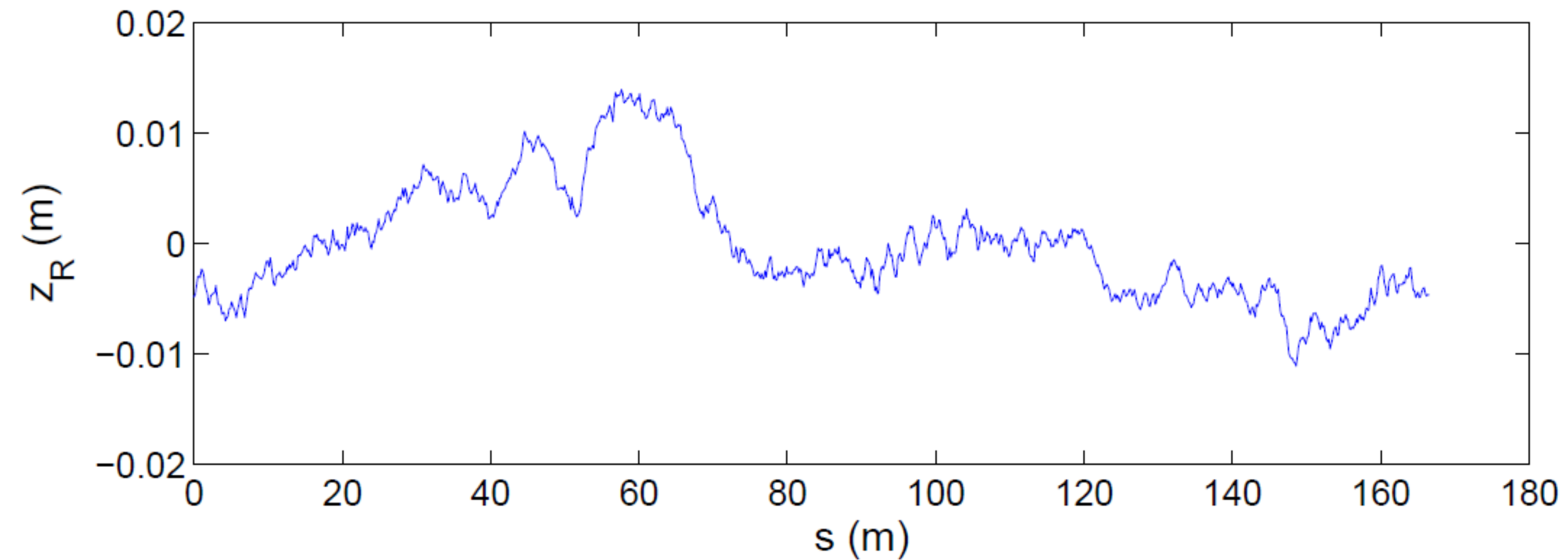
Results

Conclusions



Road modelling

The results presented here are obtained on a generated (random) road profile:



Tyan 2009

Very poor Average Very good





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Vehicle modelling

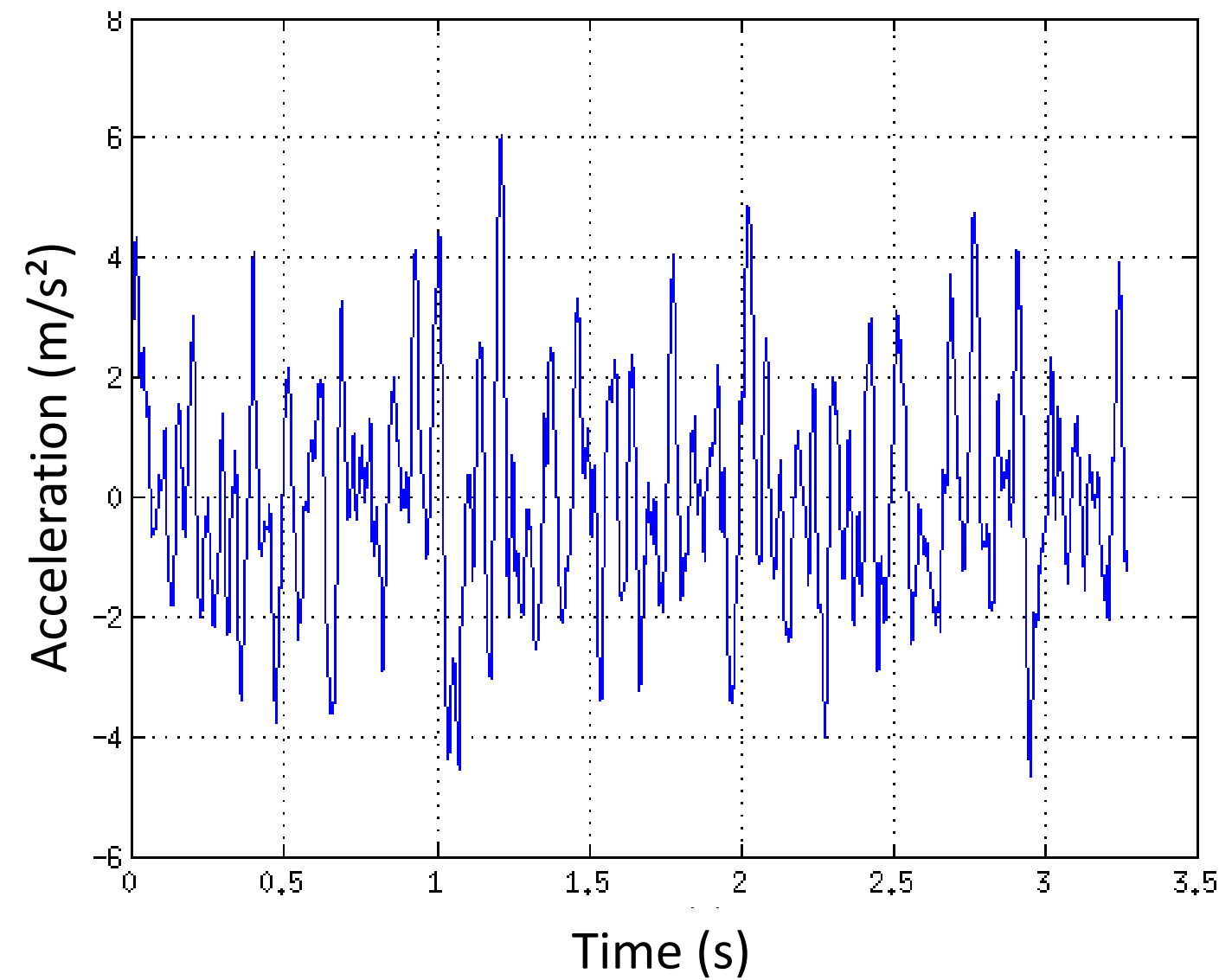
Road modelling

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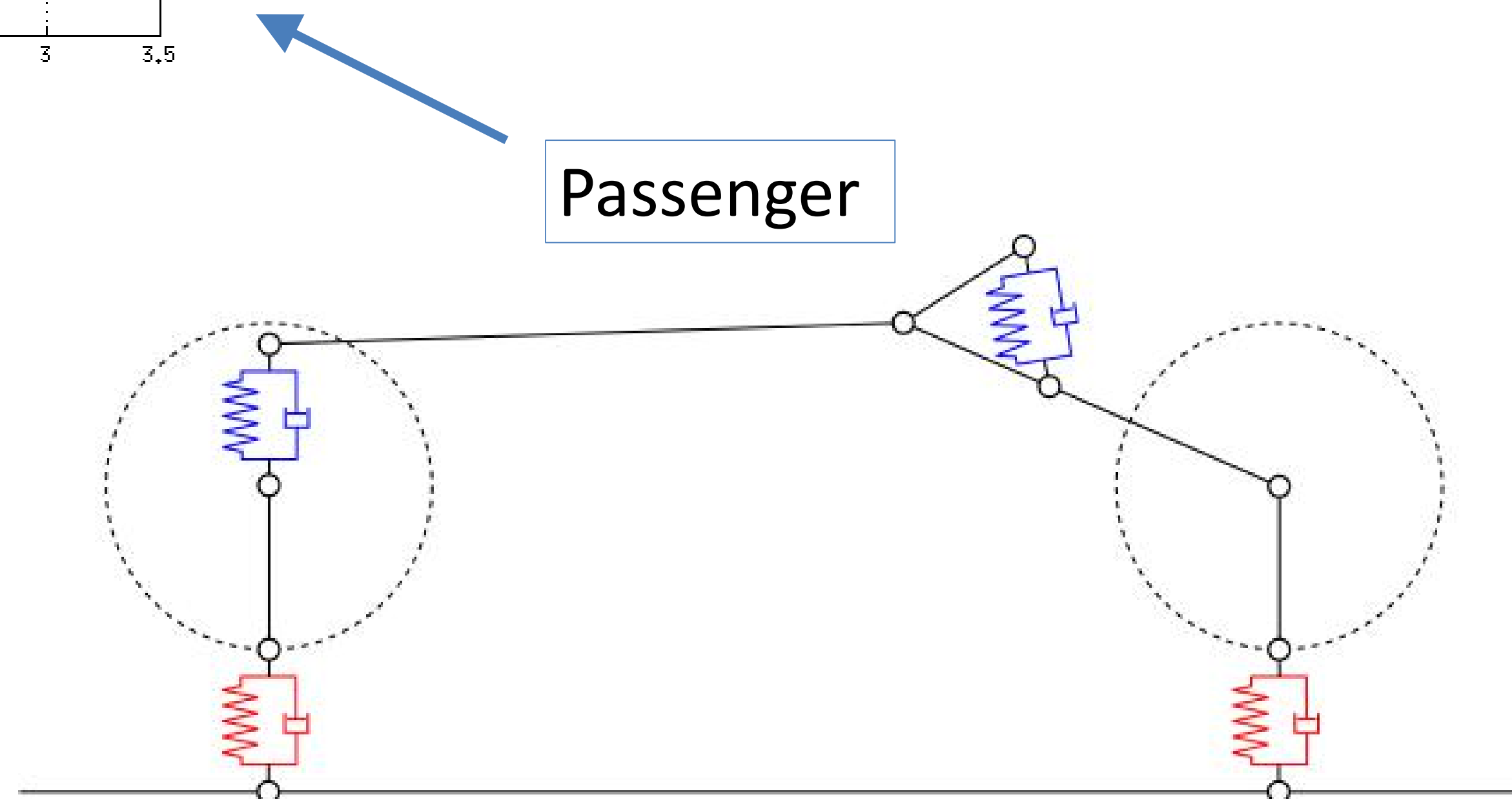
Conclusions



Based on the accelerations felt by the passenger.

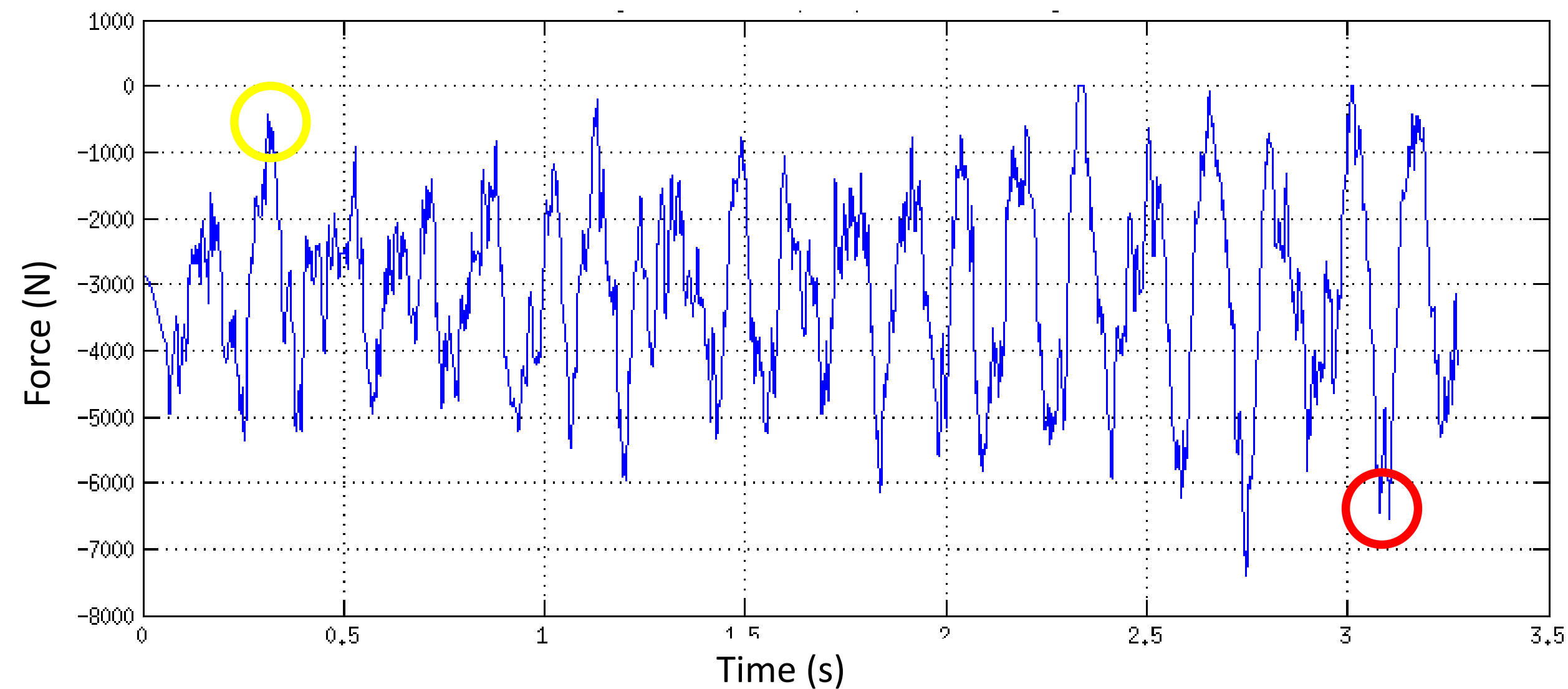
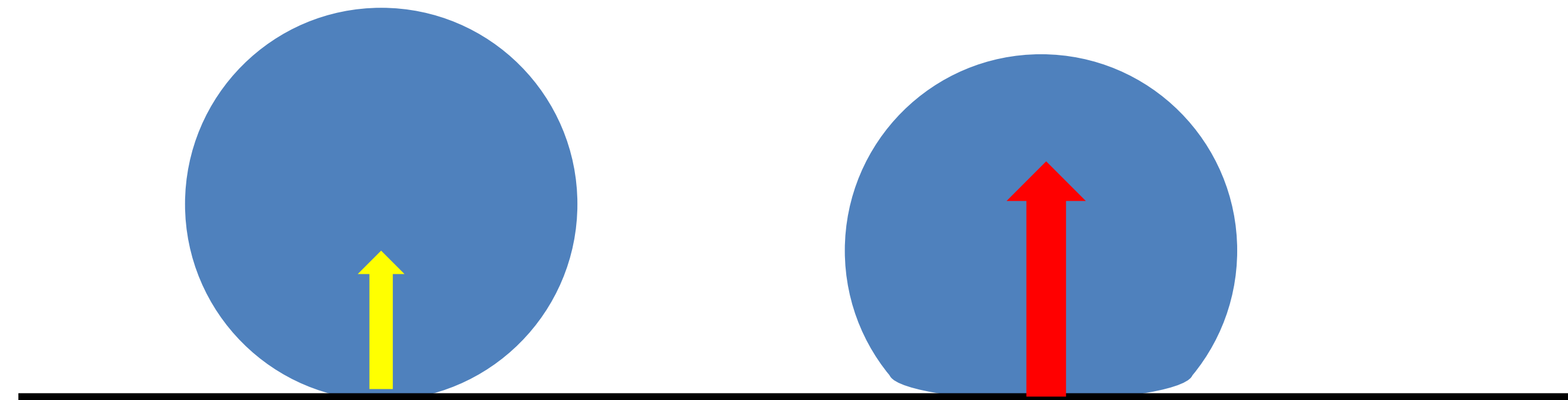
Filters are used to only use relevant frequencies.

The higher = the worst



Road holding

We have made the choice to consider the contact force between the road and the wheel as a road holding criterion



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For the **road**

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For the **comfort**

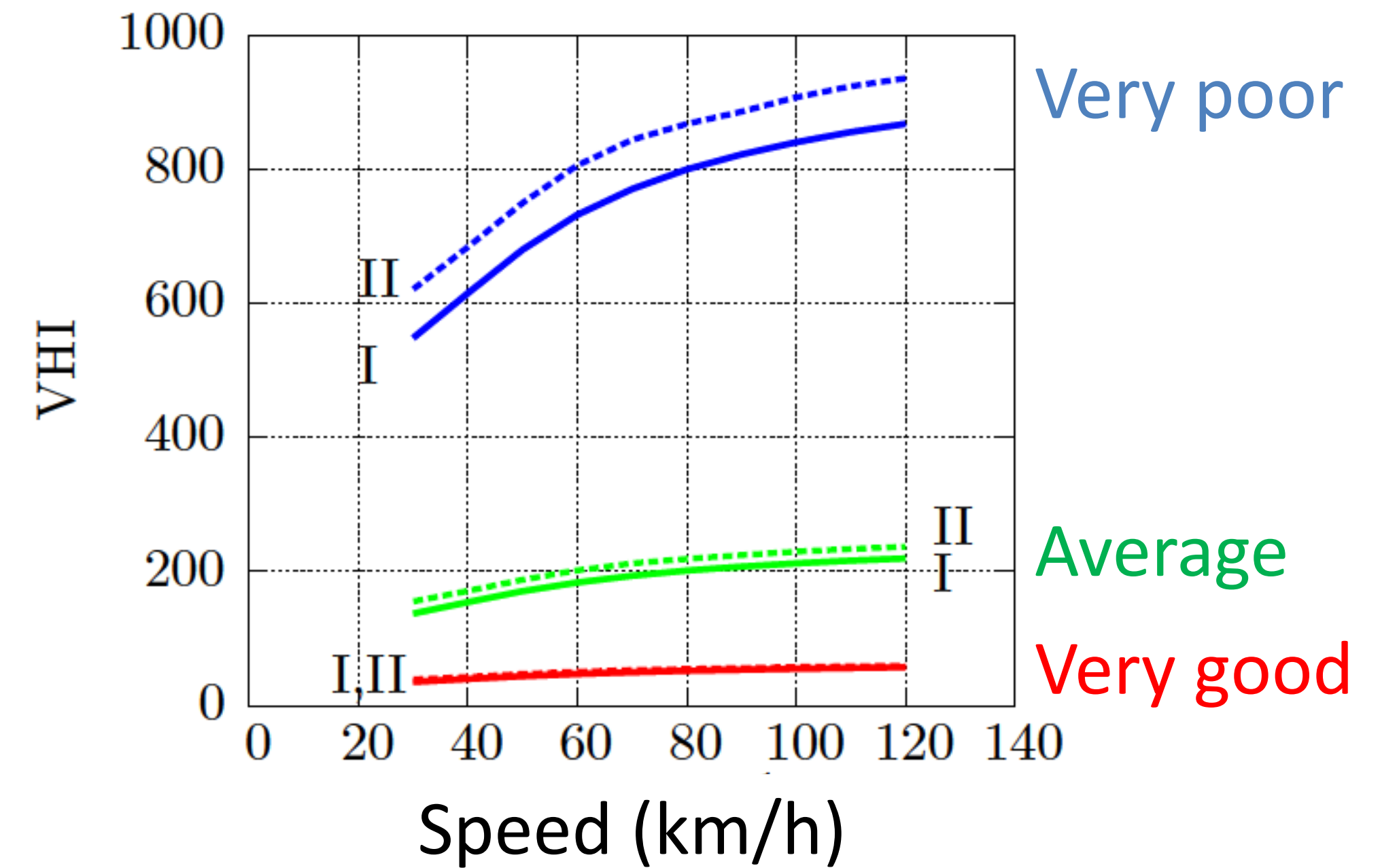
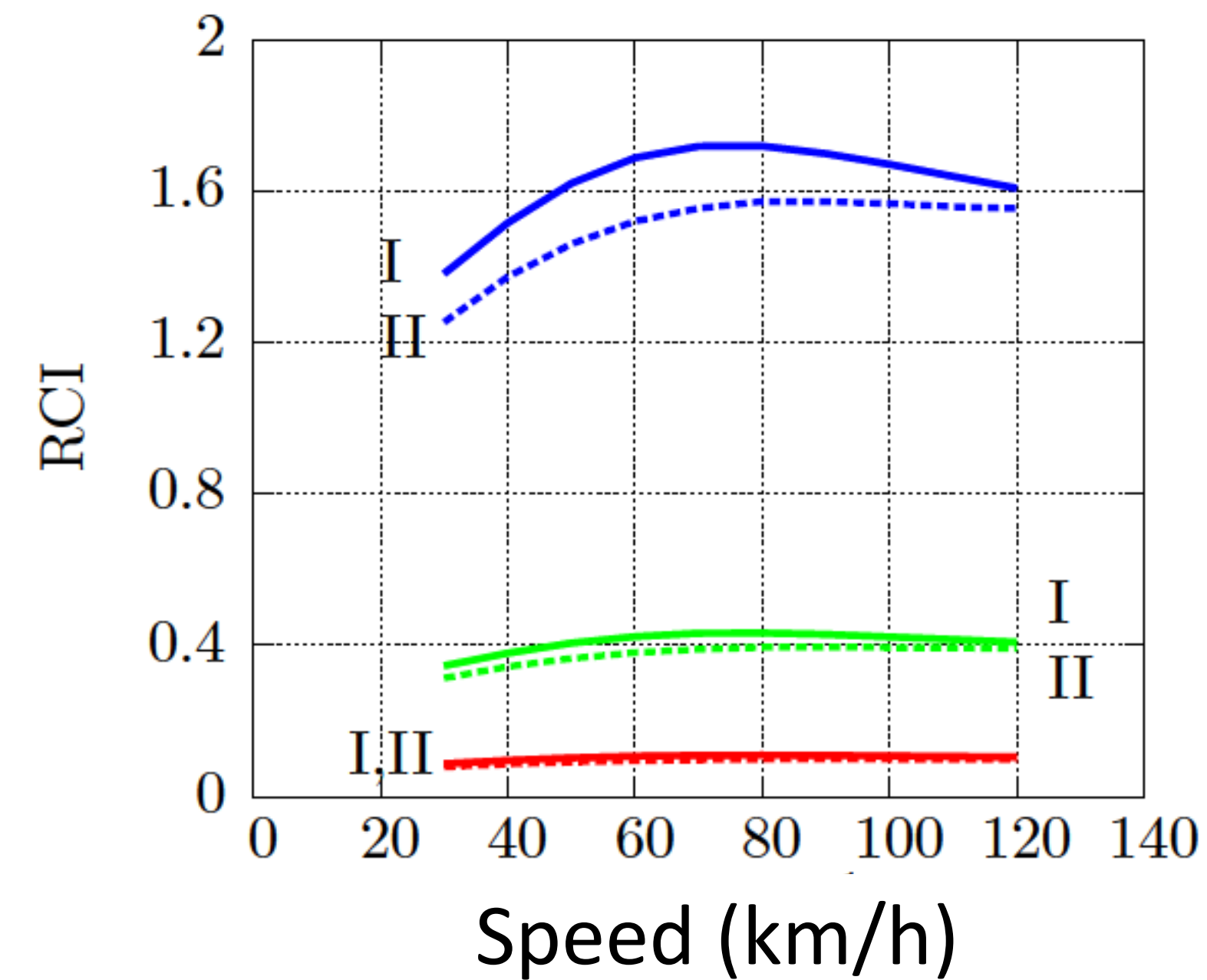
For the **road holding**

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Results

Evolution of ride comfort and vehicle handling according to speed

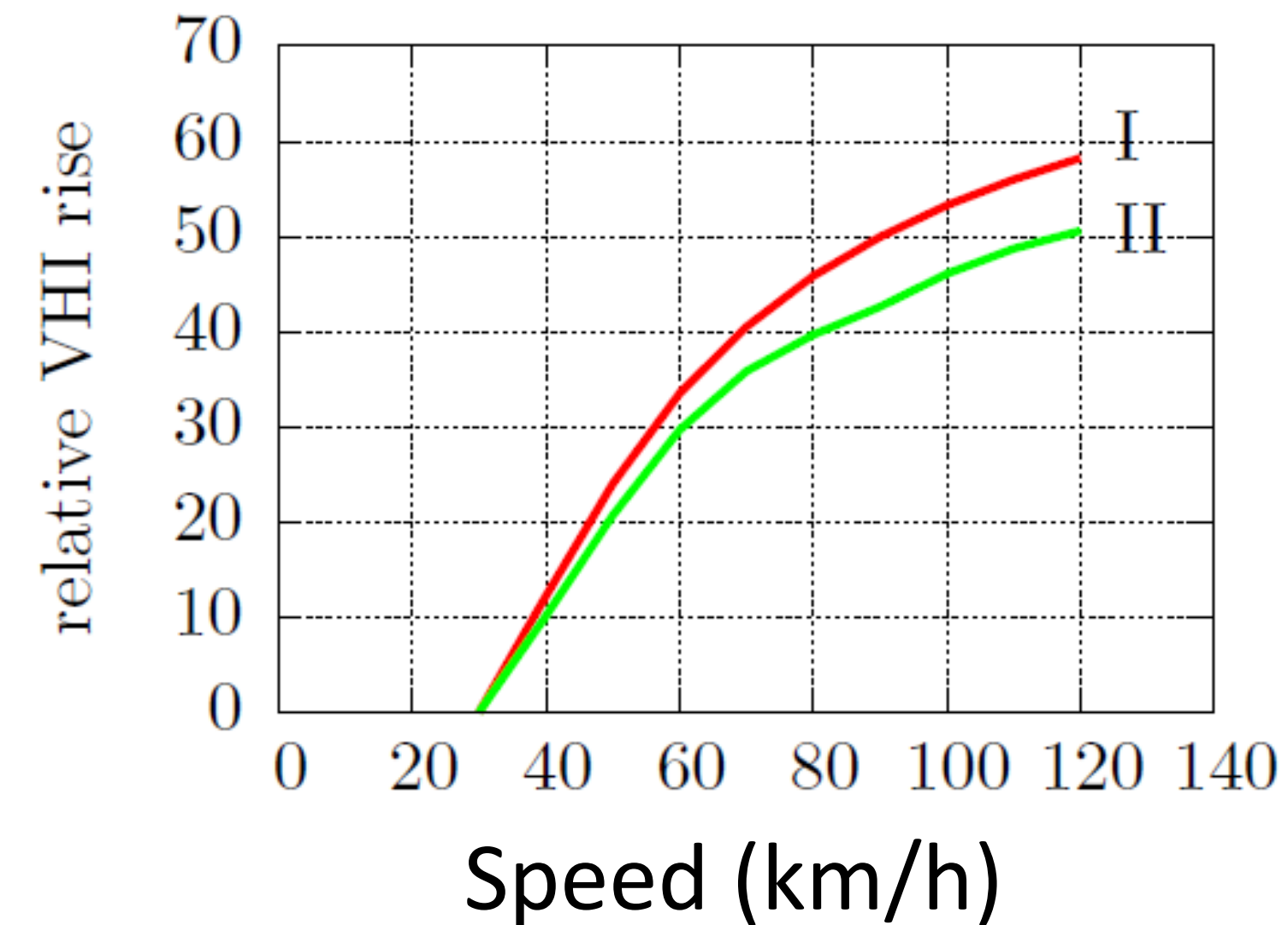
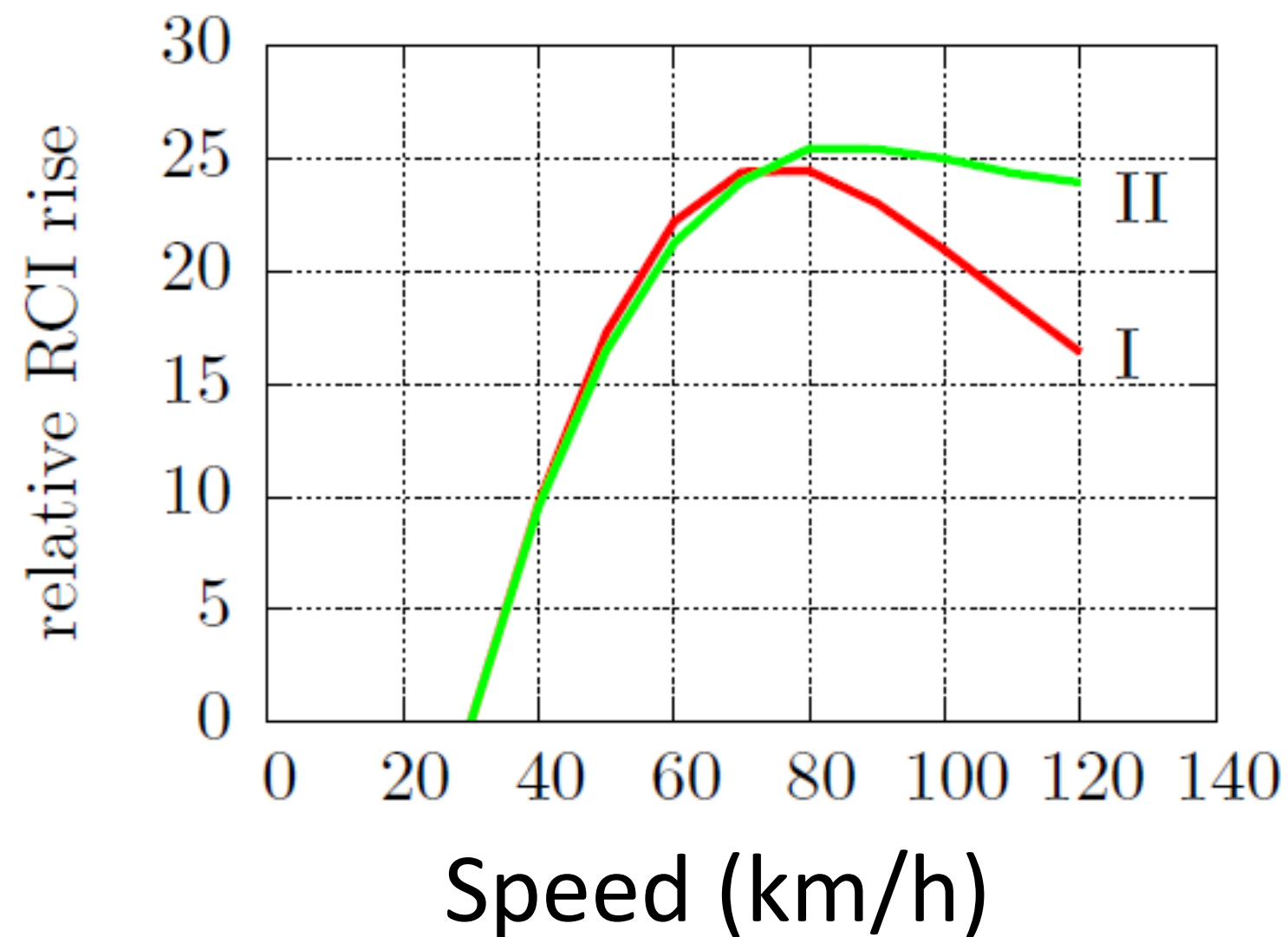


- Degradation of comfort until 60-80 km/h
- Continuous degradation of vehicle handling

I: Classical configuration
II: Oscillating arm

Results

Evolution of ride comfort and vehicle handling according to speed



- Comfort evolution is similar until 70 km/h, then the classical configuration shows a better behavior
- The oscillating arm has a slightly better evolution regarding ride handling evolution

I: Classical configuration
II: Oscillating arm

Results

Evolution of ride comfort and vehicle handling according to unsprung masses

Context

Vehicle modelling

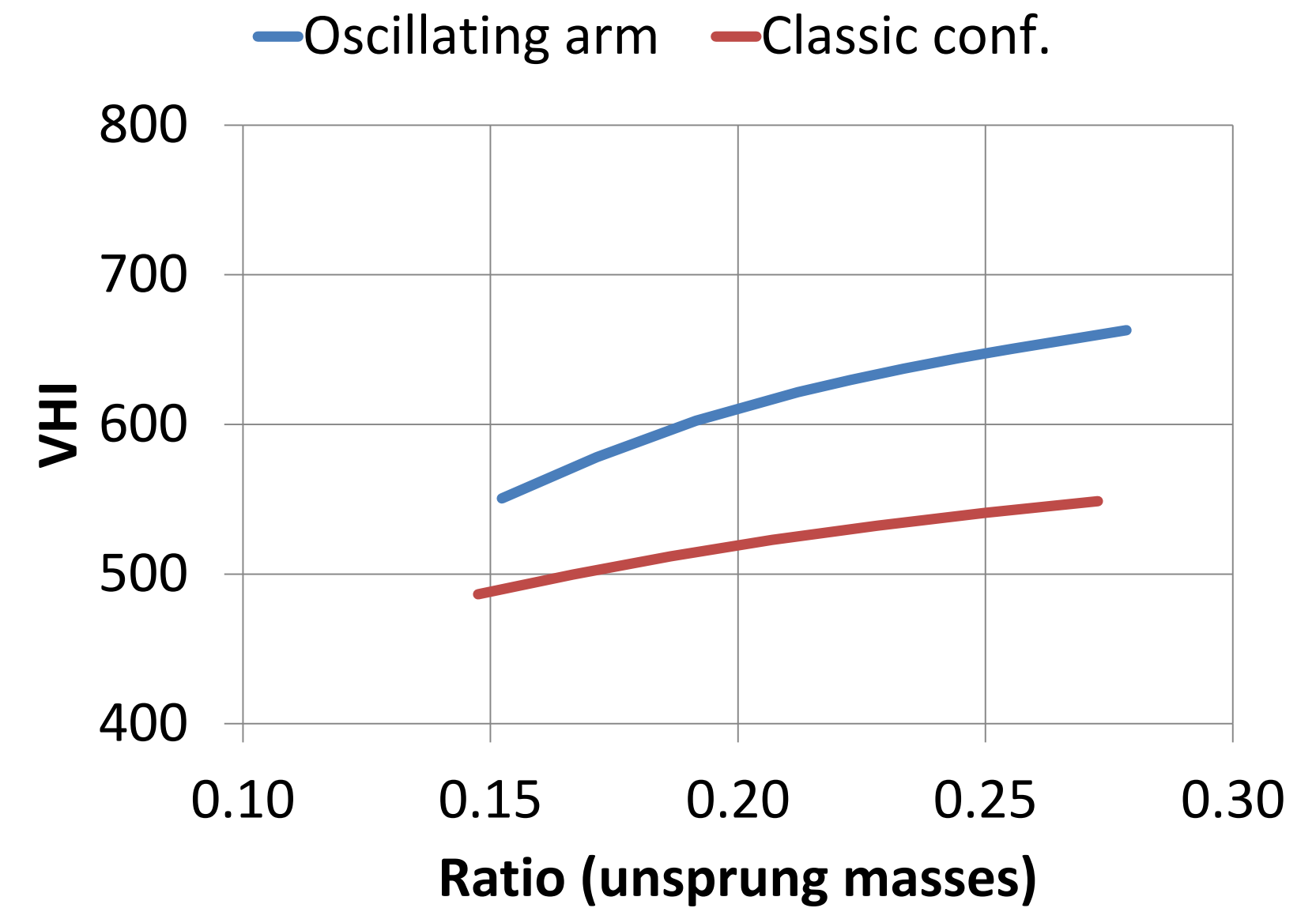
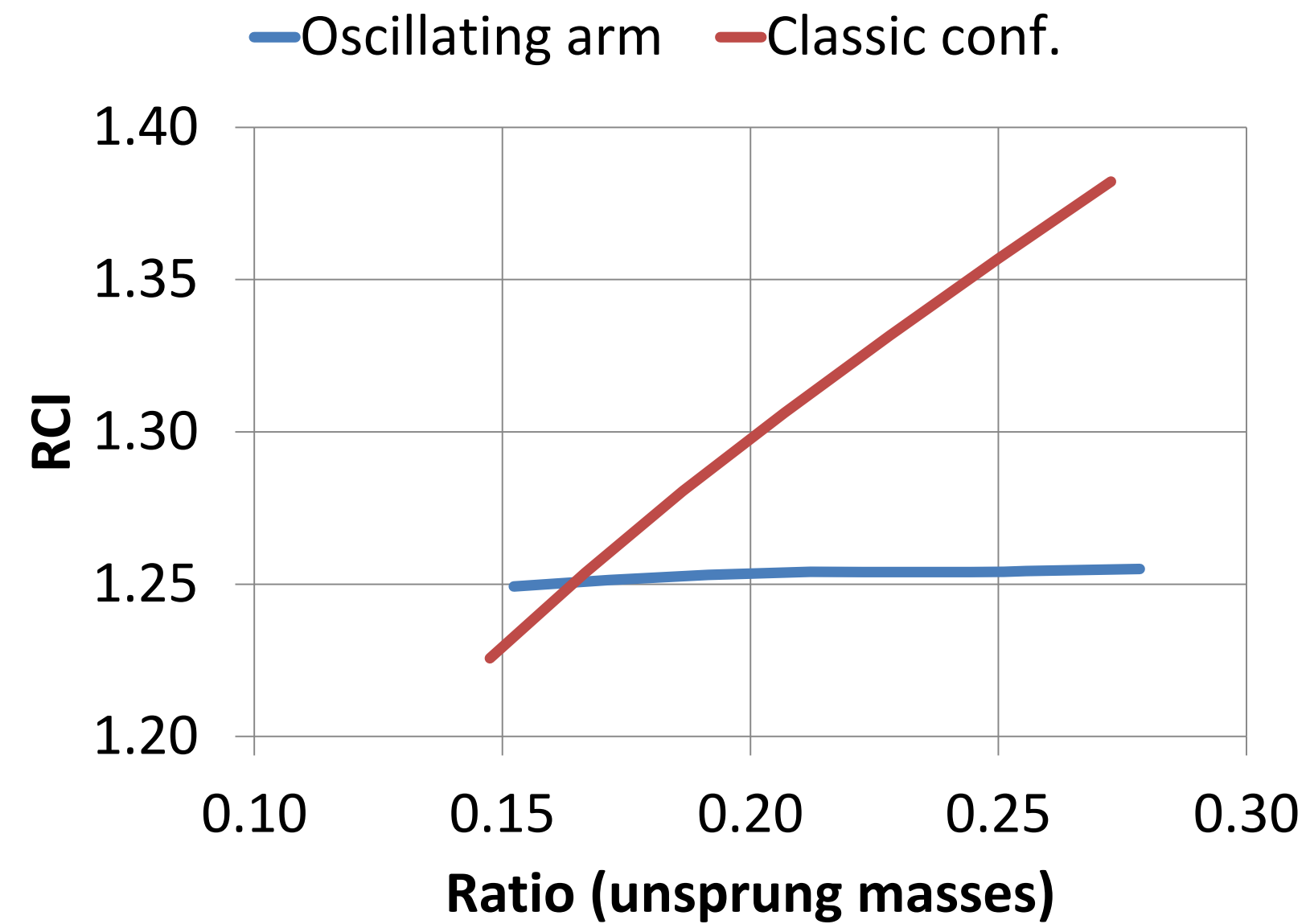
Road modelling

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- The evolution of unsprung masses on comfort is negligible for the swing arm
- The ride handling follows a similar tendency with both configurations

Results

Evolution of ride comfort and vehicle handling according to unsprung masses

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Vehicle modelling

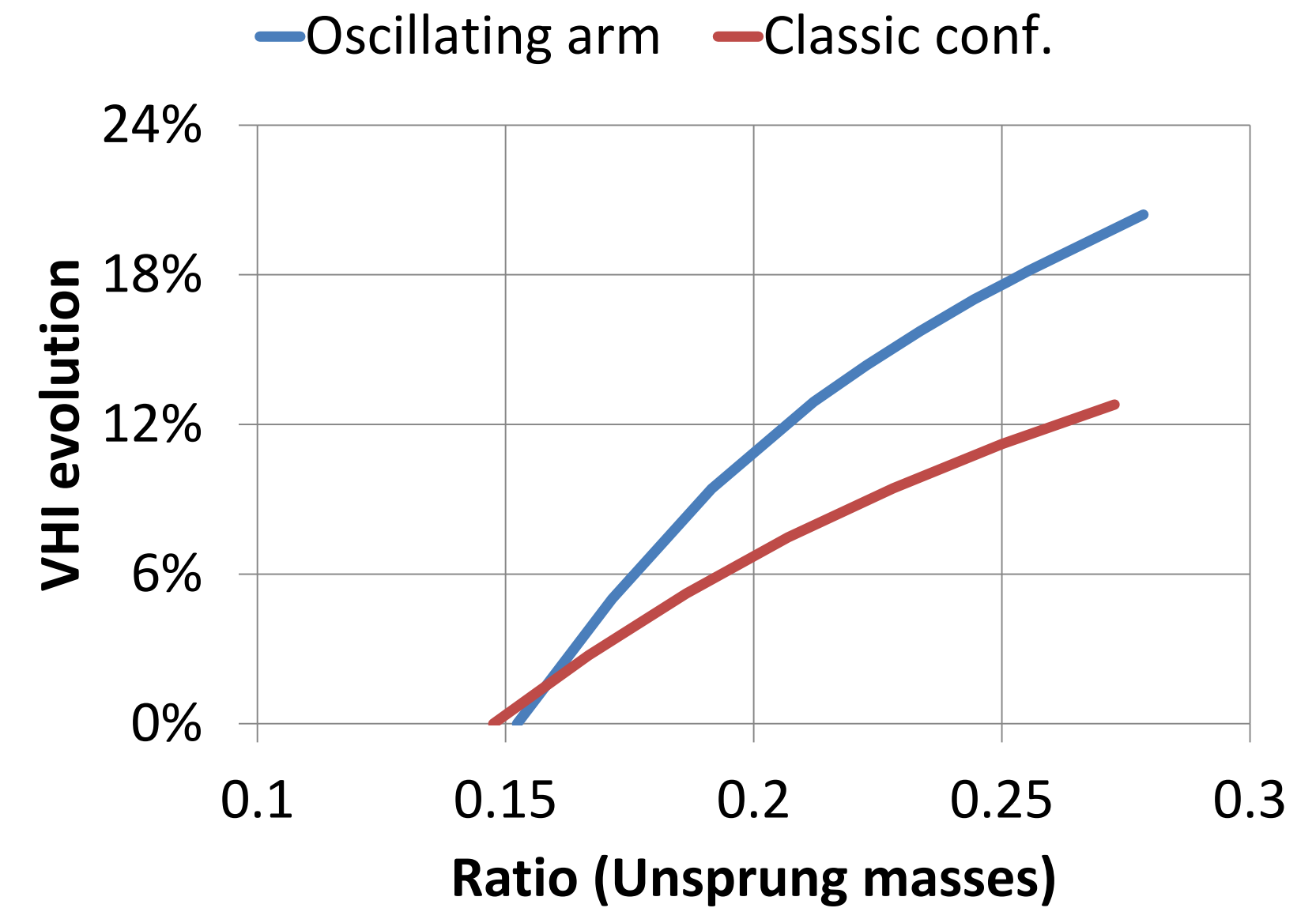
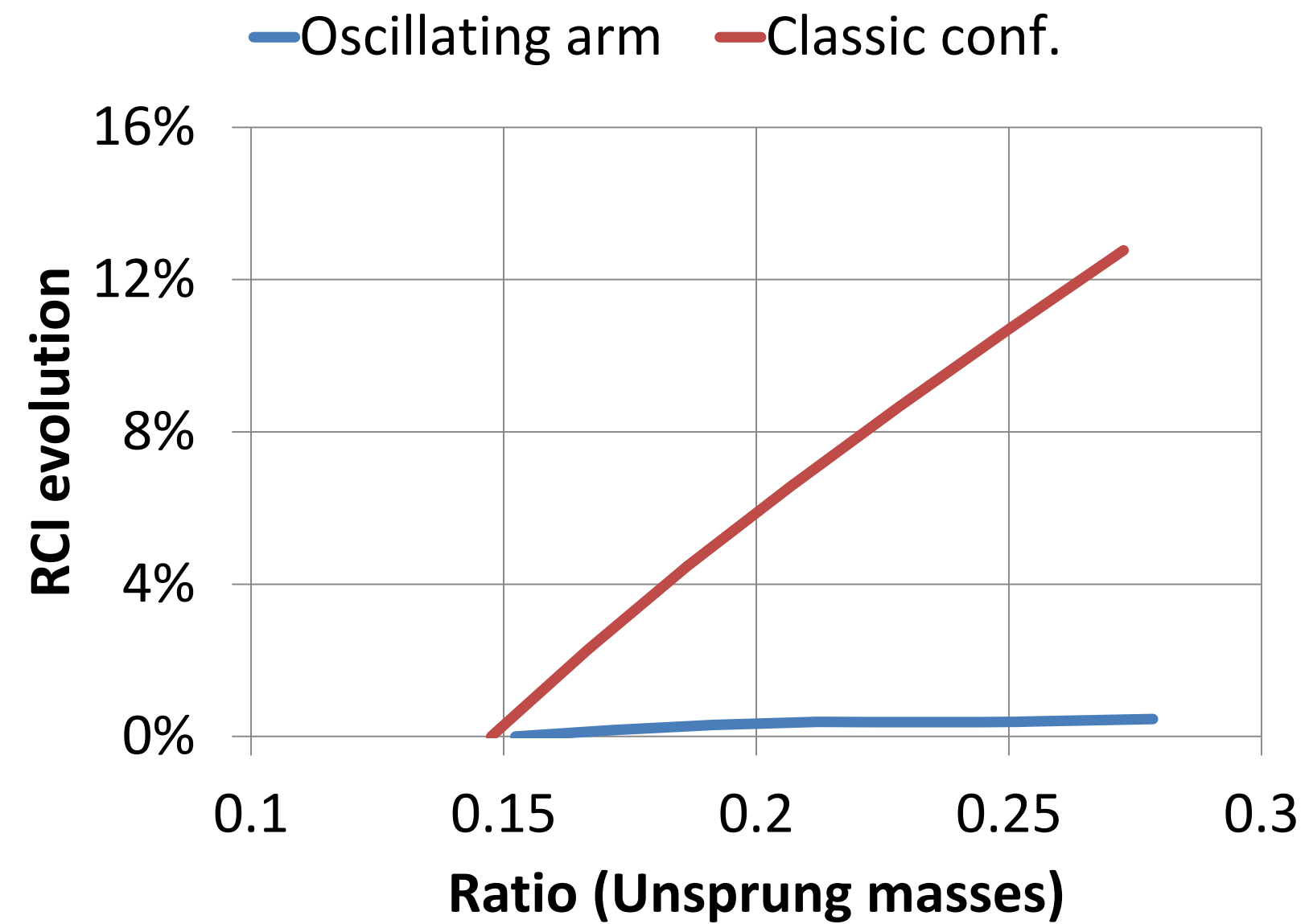
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- +0.5% for the oscillating arm
- +12.5% for the classic configuration
- +20% for the oscillating arm
- +12.8% for the classic configuration



Conclusions

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Vehicle modelling

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- The evolution of the two indexes according to speed doesn't show a better solution
- The behavior of the swing arm is almost not affected by the ratio of unsprung masses

Next step :

- Work on the design of an oscillating arm combined with this model

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