NEW METHOD FOR ON-BOARD CAR SUSPENSION TESTING

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ÚSTAV
KONSTRUOVÁNÍ

CONTENT

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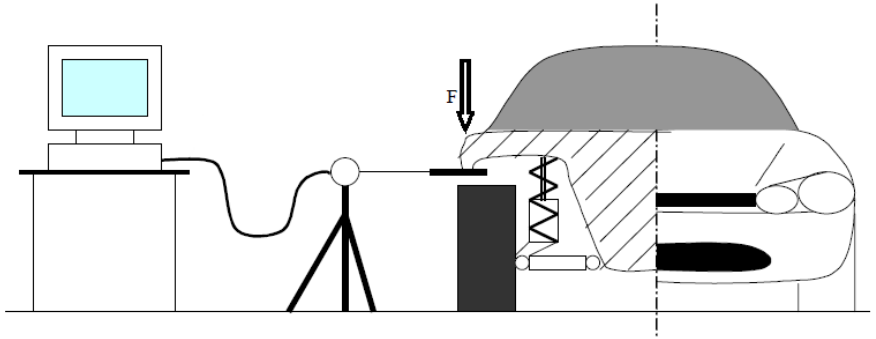
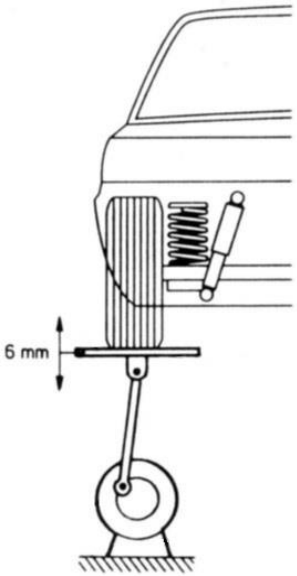
MOTIVATION

Car shock absober

- vehicle safety
- wear
- necessary to check the function



Impulse tester



EUSAMA tester

EUSAMA

- resonance test method
- fail due to the use of low profile tire types and modern chassis adjustment

Impulse testers

- problem of exciting vehicles with recently used rigid suspension

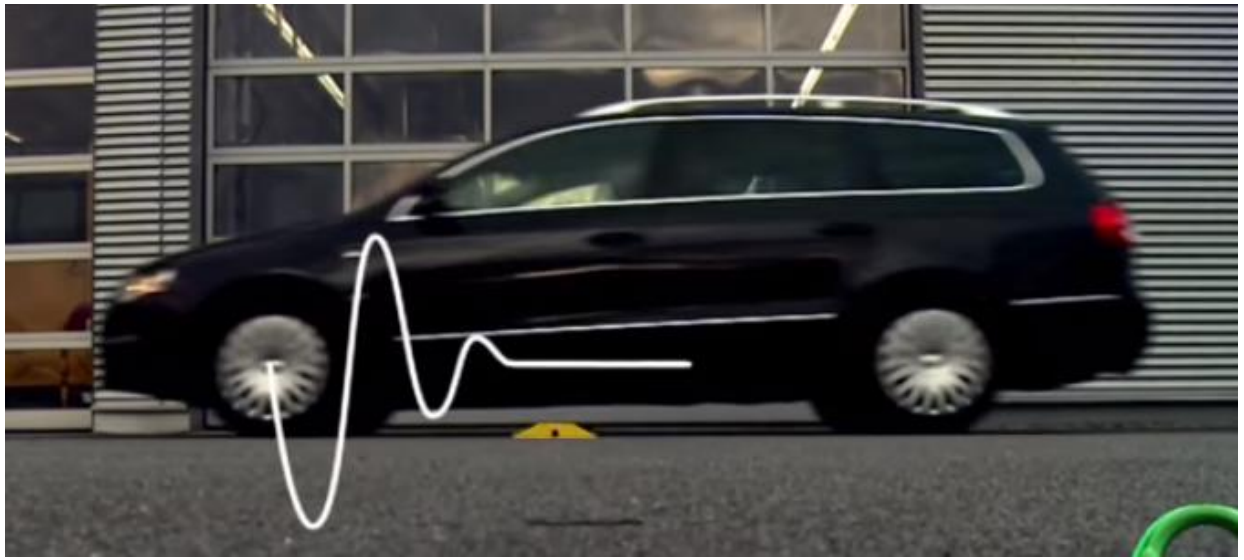
$$EUS = \frac{F_{min}}{F_{st}}$$

Necessary to solve this situation

- improvement of some existing method or development of new ones

MAIN AIM

The development and validation of the methodology based on the obstacle crossing and the analysis of the suspension damping ratio



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MATERIALS AND METHODS

Obstacle crosses

- obstacle: high – 0.08 m, length – 0.43 m
- 5 times run over
- left and then right side
- same speed necessary → first gear (idling)

Inertial measuring unit

- located behind the driver‘s seat
- sences vertical acceleration and angular velocity around longitudinal and transverse axes of the car body during crosses

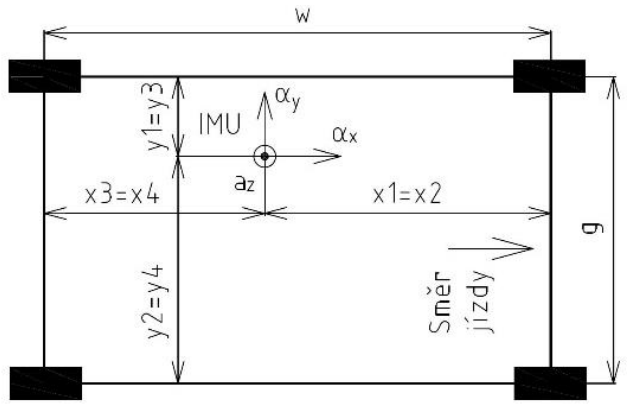
Car and obstacle during the on board test

IMU location in the vehicle

MATERIALS AND METHODS

Calculation of the vertical acceleration of the car body at the suspension points

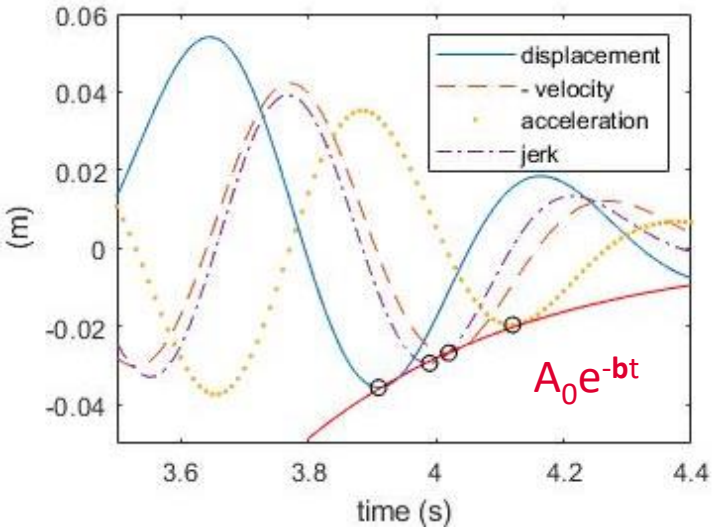
- known wheelbase, gauge, IMU position
- $a_i = a_z + (-1)^i y_i \alpha_x + (-1)^i x_i \alpha_y$



IMU location schema

Standardized differentiation method

- acceleration integrated or derived to displacement, velocity and jerk
- quantities standardized to same physical dimension, divide/multiply by ω, because $y = A \cdot \sin(\omega t + \varphi)\,, \dot{y} = \omega \cdot y$
- exponential envelope $y = A_0 e^{-bt}$
- <u>damping ratio</u> $b_r = \frac{b}{\omega}$



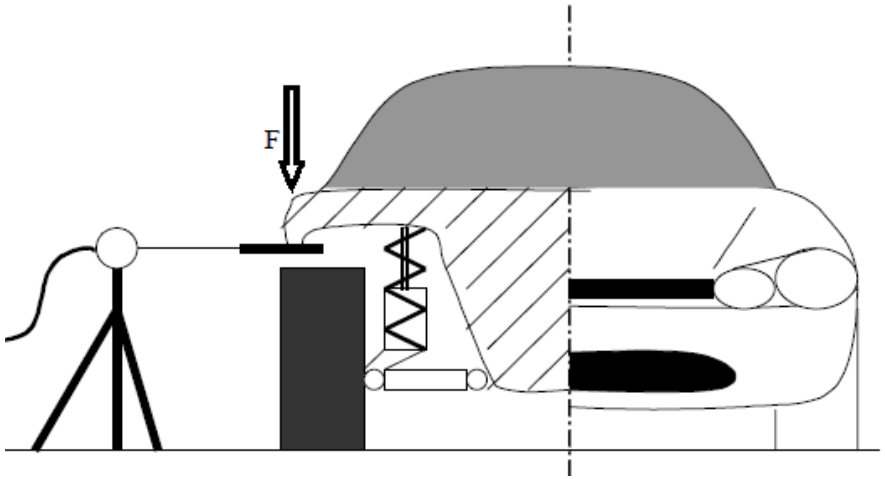
standardized derivation schema

MATERIALS AND METHODS

Experimental verification

- 65 vehicles
- comparison with impulse tester TriStar
  - manual excitation
  - displacement measuring
  - damper velocity must be within the range of 0.2 to 0.3 ms^{-1}
  - same evaluating method (standardized evaluating method)

- comparison of differences between shock absorbers conditions
- comparison of cars as a whole



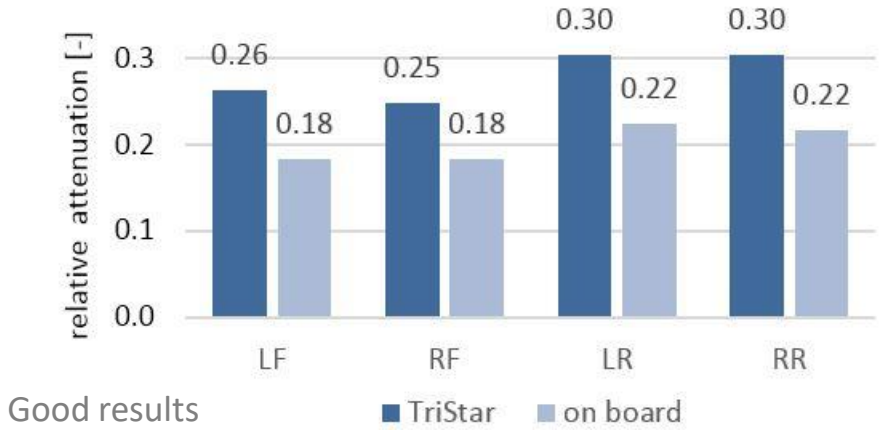
Tristar impulse tester

RESULTS

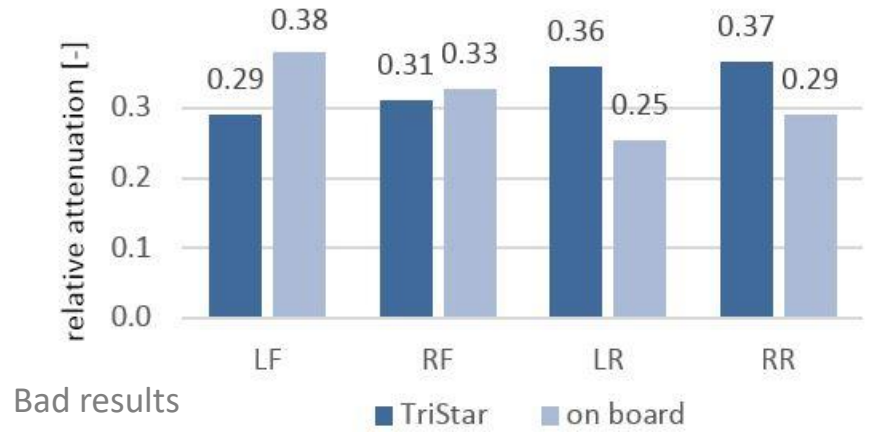
Comparison of differences between shock absorbers conditions

- satisfactory results only for some cars

Average deviation difference	
front wheels	13 %
rear wheels	8 %
axles	18 %



Good results

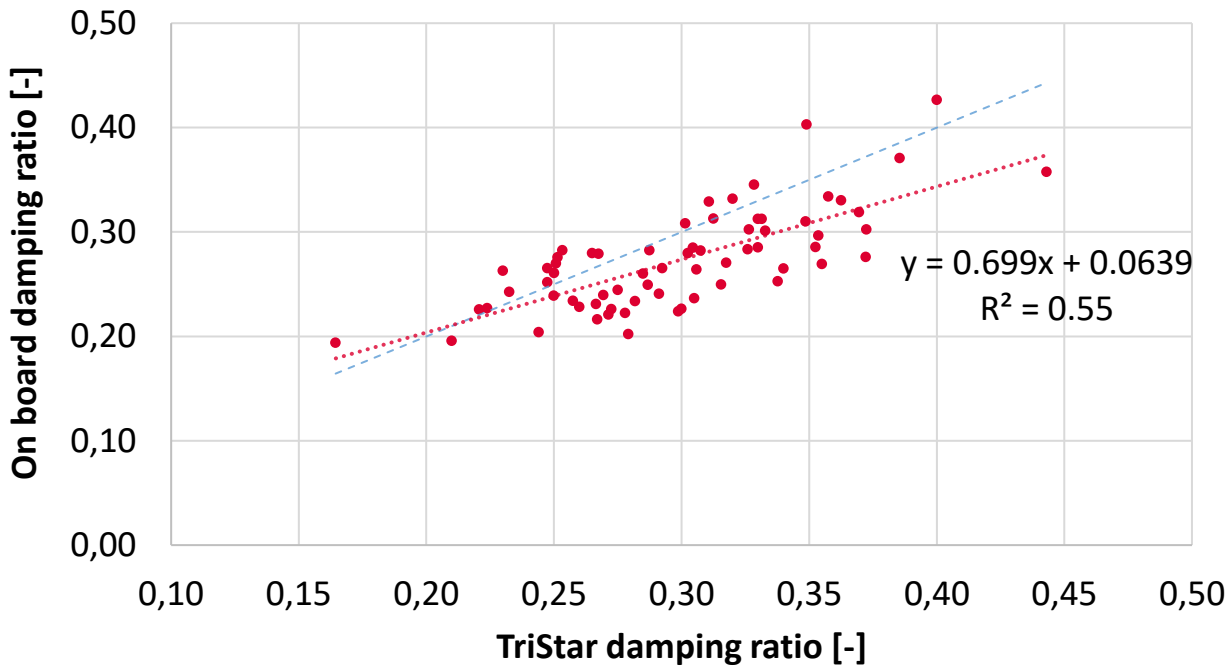


Bad results

RESULTS

Comparison of cars as a whole

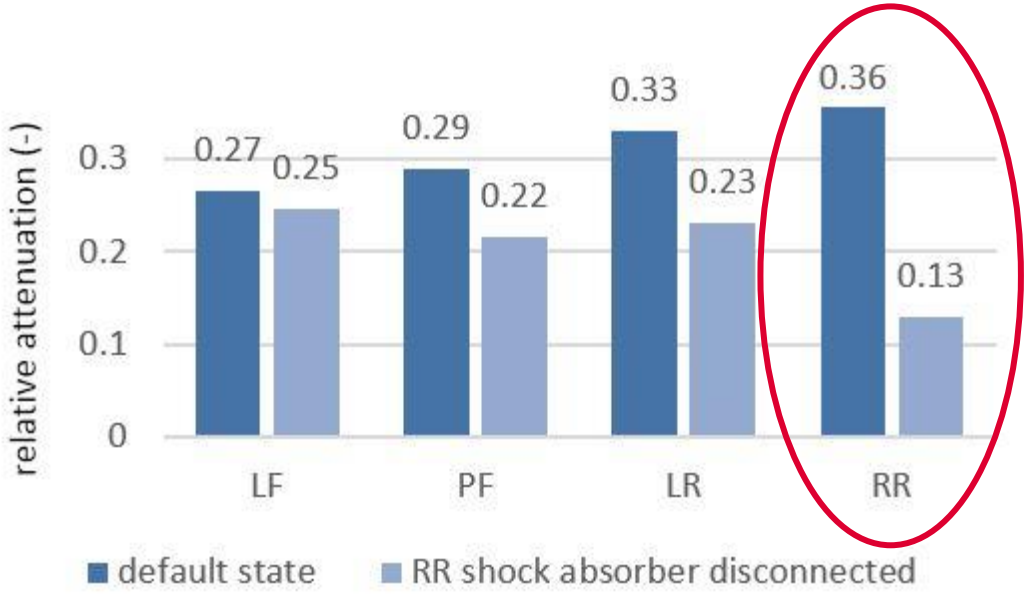
- damping ratio of each suspension was averaged in a single number for each vehicle for both the TriStar and the on board tester
- methods follow the same trend
- large variance, $R_2 = 0.55$
- ploted ideal line x = y (- - - -)



RESULTS

Detection of shock absorber that is completely out of service

- randomly selected Škoda Roomster
- RR damper disconnected
- easy to detect
- decrease damping ratio of other suspension
  - car is complex system
  - movement damped by all dampers



CONCLUSION

Proposed a new method of evaluating of shock absorbers based on on-board testing

- problem with controlling the expansion velocity of the shock absorber during the test
  - each damper is measured under different conditions
  - dispersion of the results

- inexpensive and less accurate alternative to the EUSAMA
- advantages: simplicity, small space and low price
- some vehicles – very good conformity between the TriStar and on board tester,
  some vehicles – relatively large dispersion
- evaluation of damping ratio may not be sufficiently reliable
- <u>binary evaluation that is most accessible to service technicians is accurate sufficiently</u>

THANK YOU FOR YOUR ATTENTION

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