

XIV Międzynarodowa Konferencja Bezpieczeństwa Ruchu Drogowego

GAMBIT 2023

NOWA DEKADA - NOWE DZIAŁANIA - NOWE TECHNOLOGIE

Politechnika Gdańska, 29-31 maja 2023



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Nowa Dekada – Nowe Działania – Nowe Technologie

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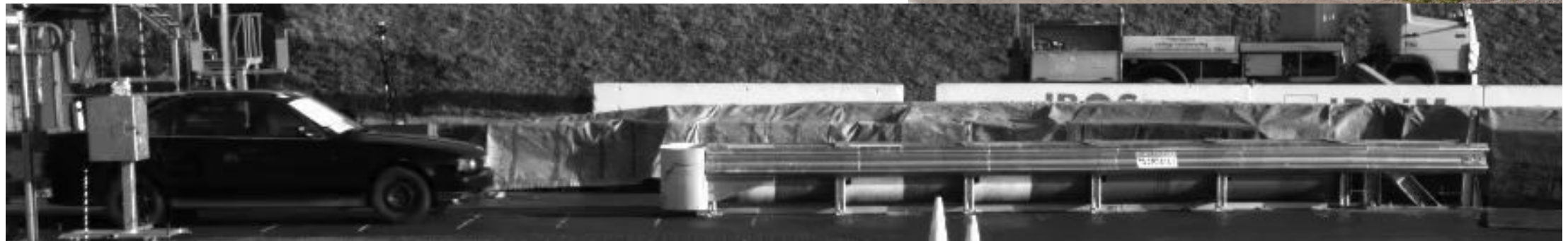
POST-TYPE CRASH CUSHIONS – ORIGIN, DESIGN, SIMULATIONS AND FIELD TESTS

Piotr Kędzierski

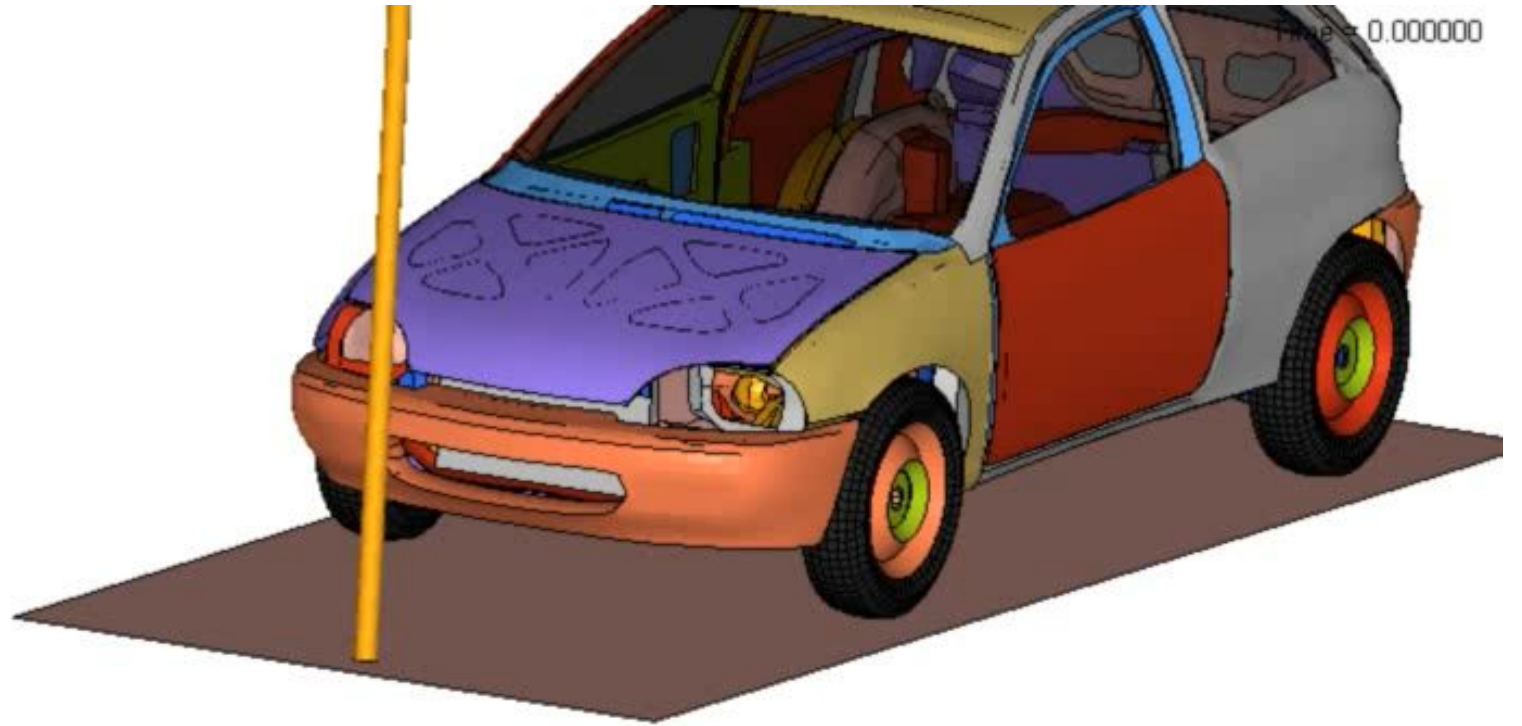


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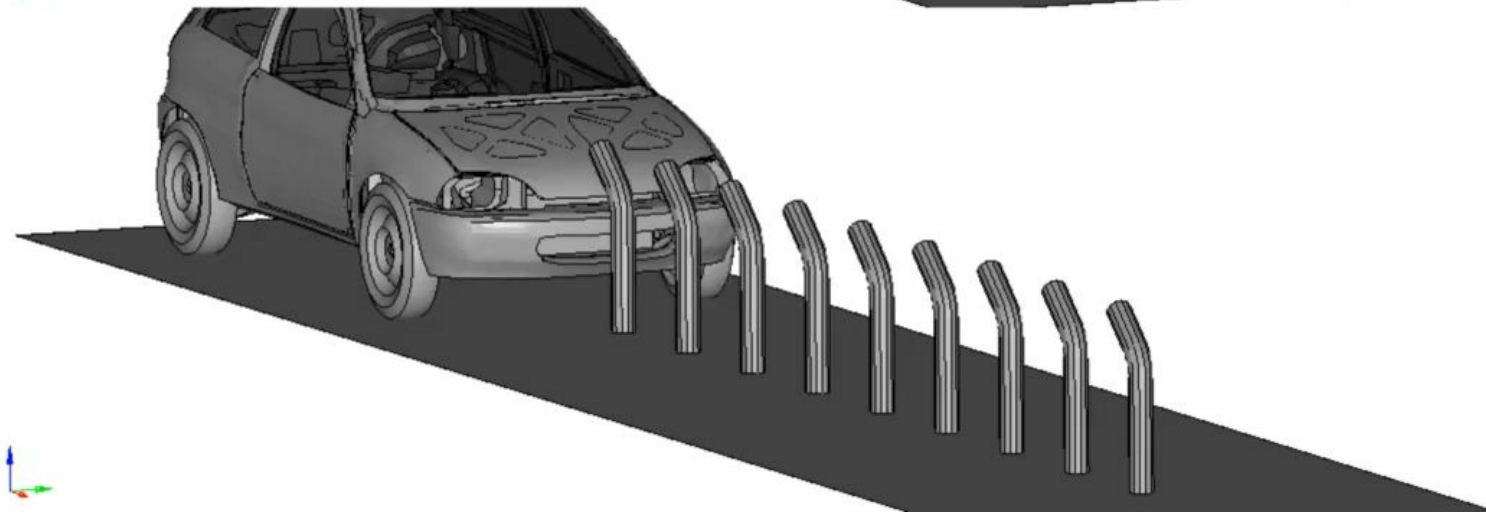
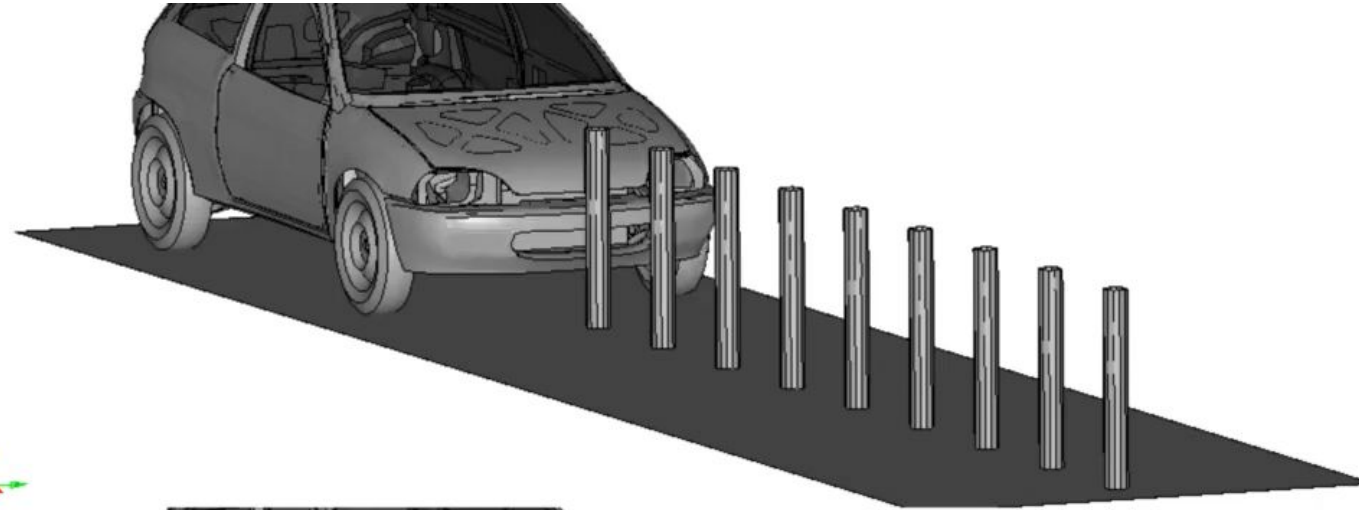
Crash cushions



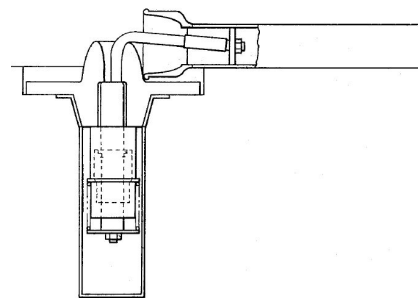
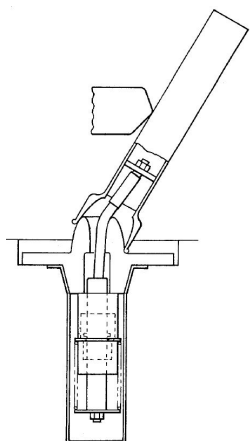
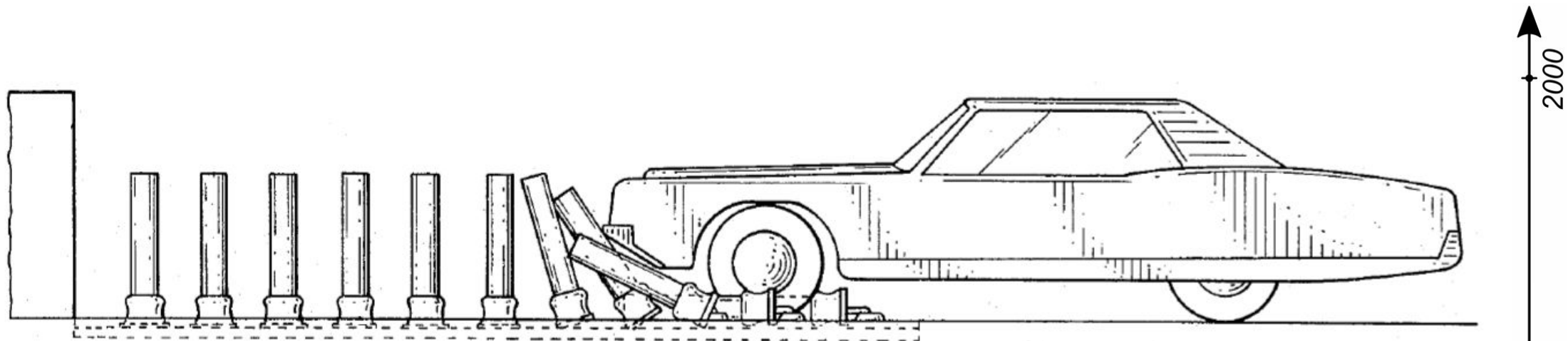
Origin of the idea



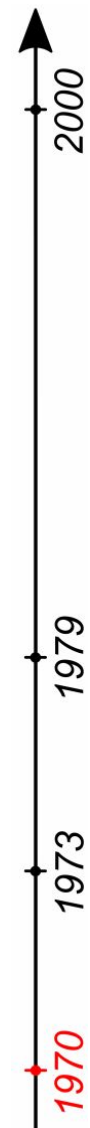
The main idea



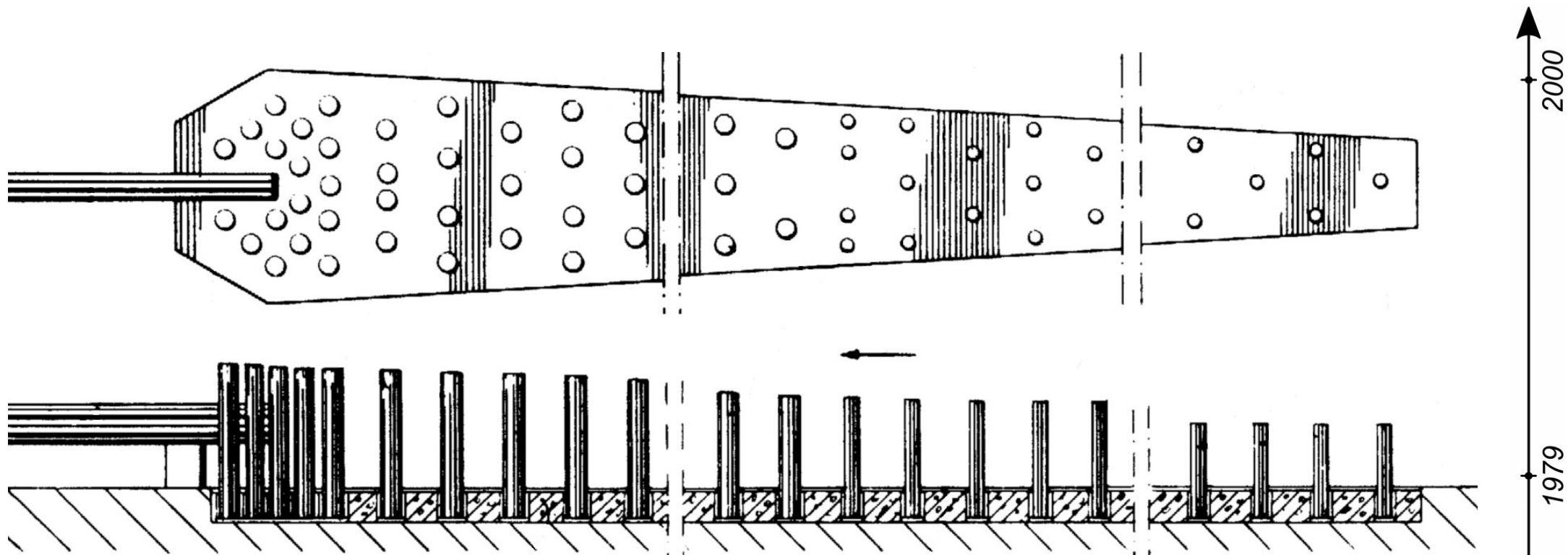
Post-type crash cushion – state of the art



US3693940
Energy absorbing barrier post assembly
Menasco Manufacturing Company

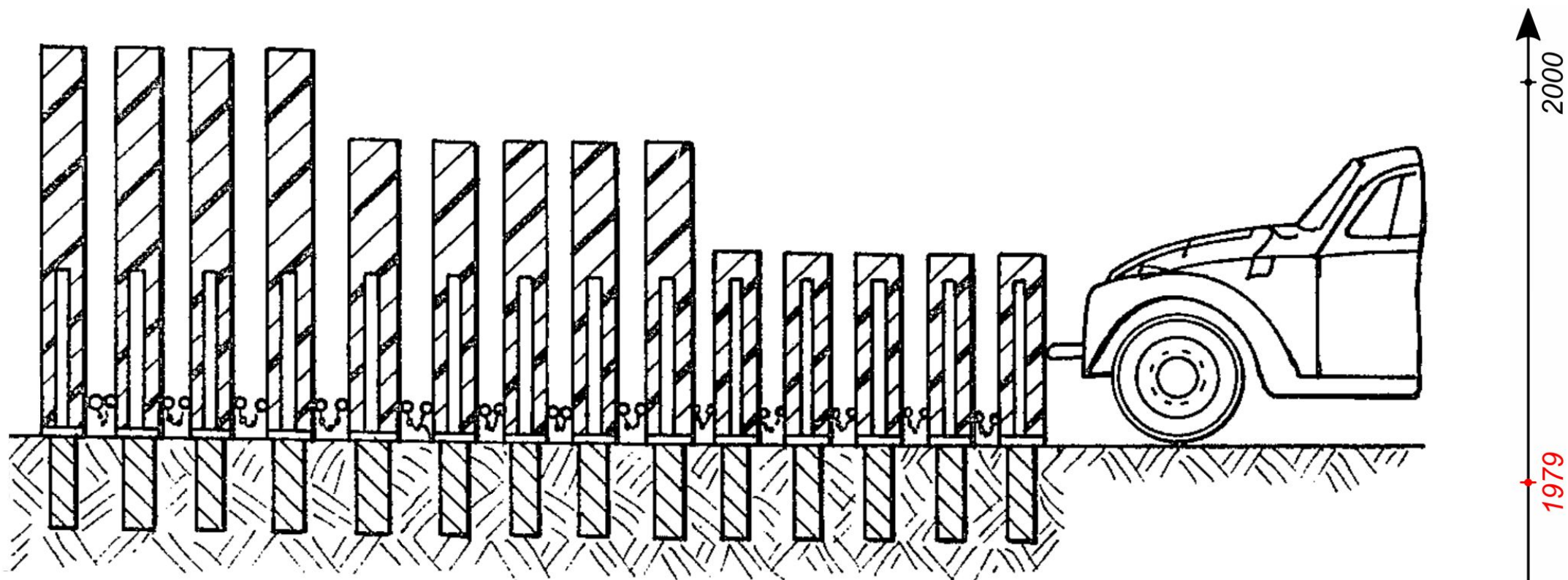


Post-type crash cushion – state of the art



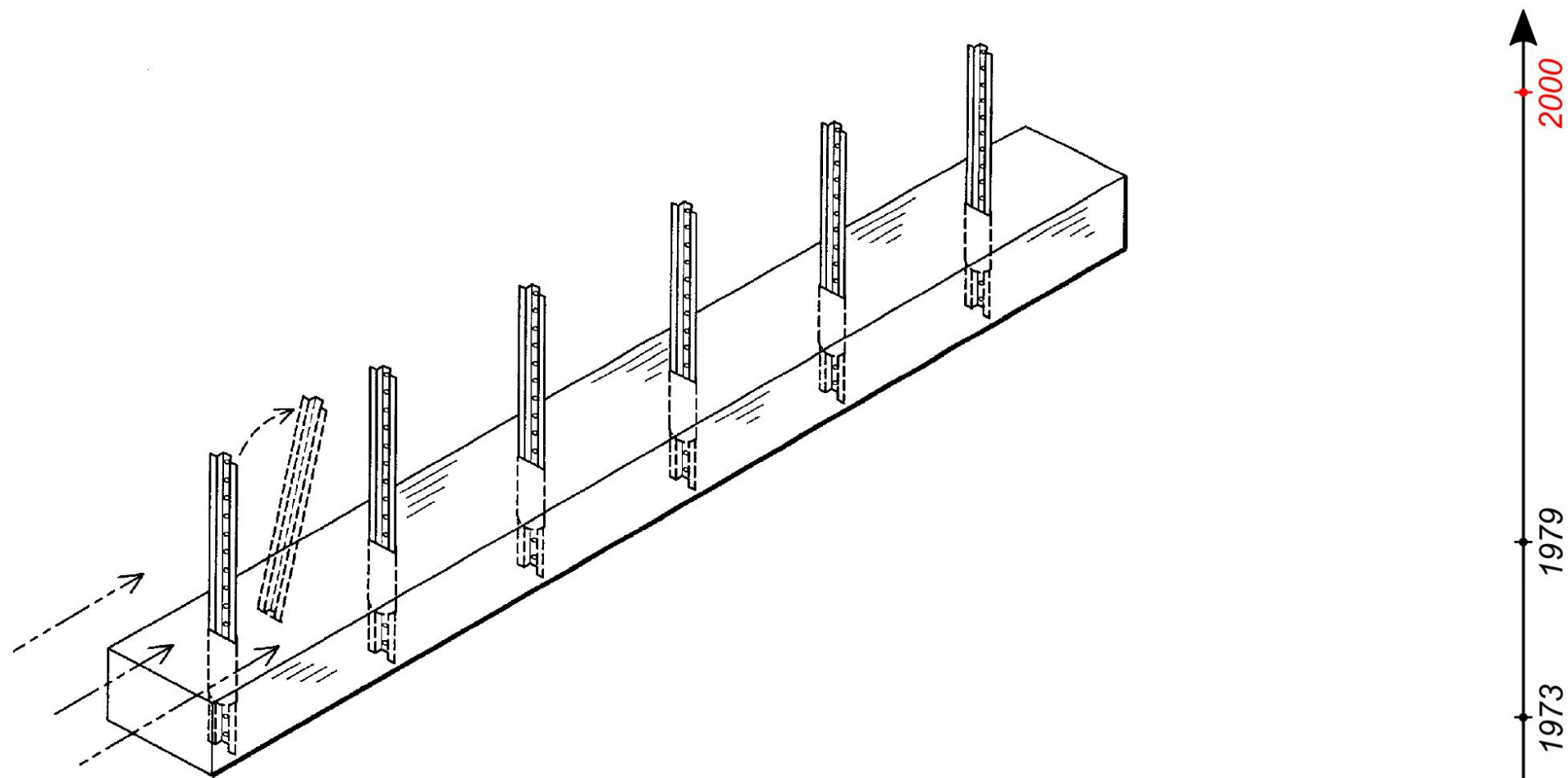
US3881697
Roadside safety apparatus
ARBED S.A.

Post-type crash cushion – state of the art



US4290585
Vehicle-stopping device for safety barriers
ARBED S.A.

Post-type crash cushion – state of the art



US6454488

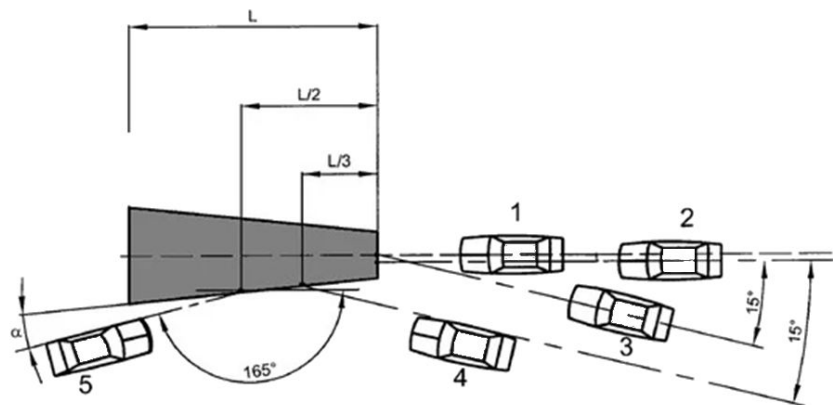
Roadway energy absorbing impact attenuator

David Lewis, David Hubbell, William Bryson, William Atwood

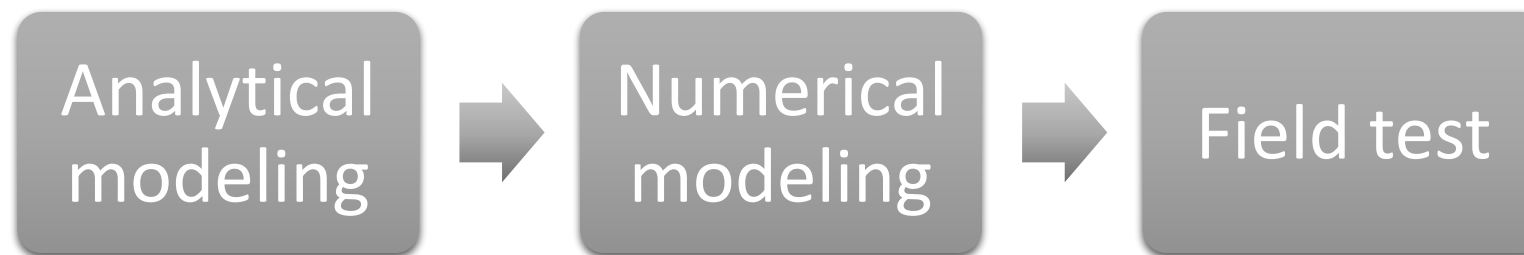
Crash cushion design

Requirements

Requirements according to the PN-EN ISO 1317-3:2010 Road restraint systems Performance classes, impact test acceptance criteria and test methods for crash cushions



Design process



Analytical modeling

$$\Delta E_k = W$$

$$\Delta E_k = \frac{mV^2}{2}$$

$$W = Fx$$

$$F = am$$

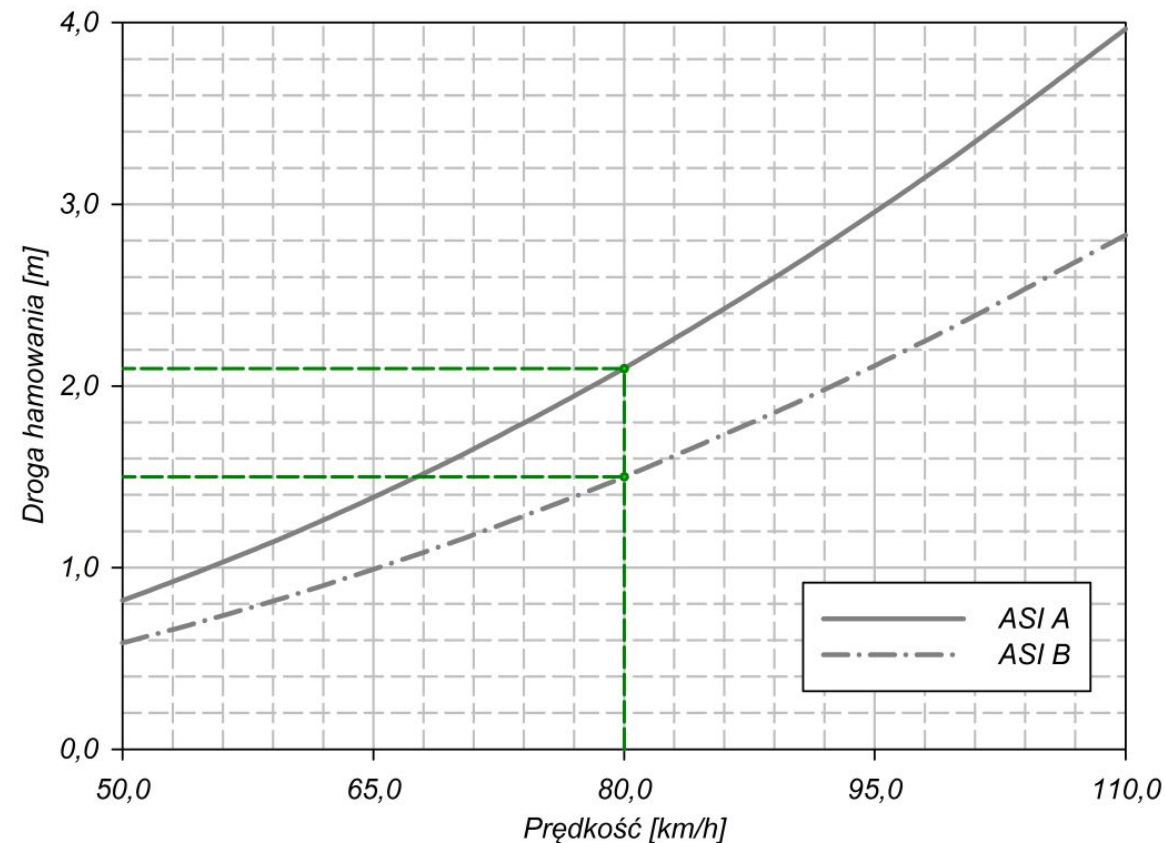
$$x = \frac{V^2}{2a}$$

$$ASI(t) = \sqrt{\left(\frac{\bar{a}_x(t)}{\hat{a}_x}\right)^2 + \left(\frac{\bar{a}_y(t)}{\hat{a}_y}\right)^2 + \left(\frac{\bar{a}_z(t)}{\hat{a}_z}\right)^2}$$

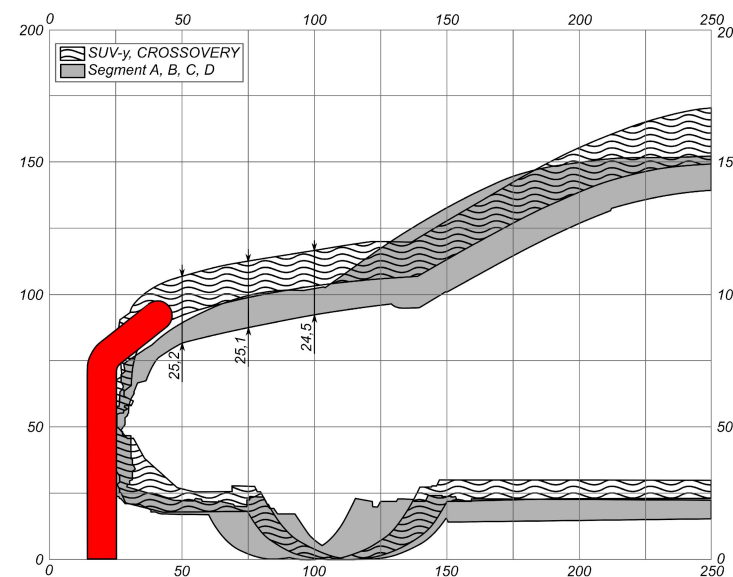
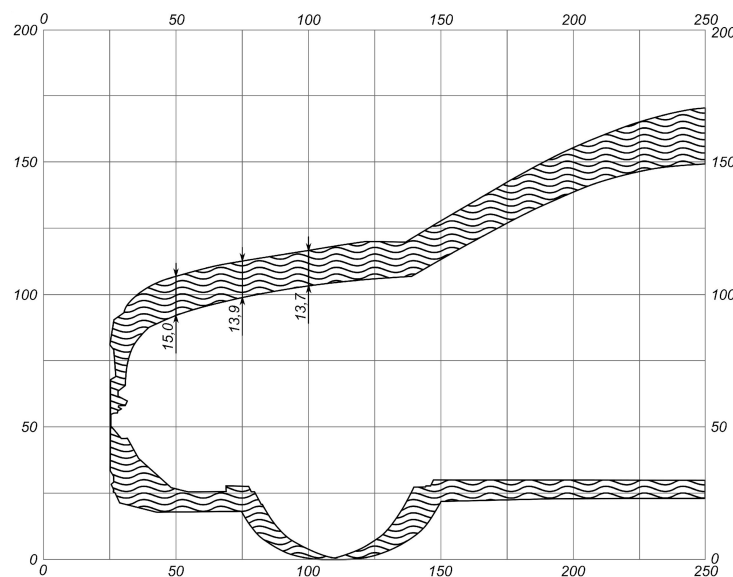
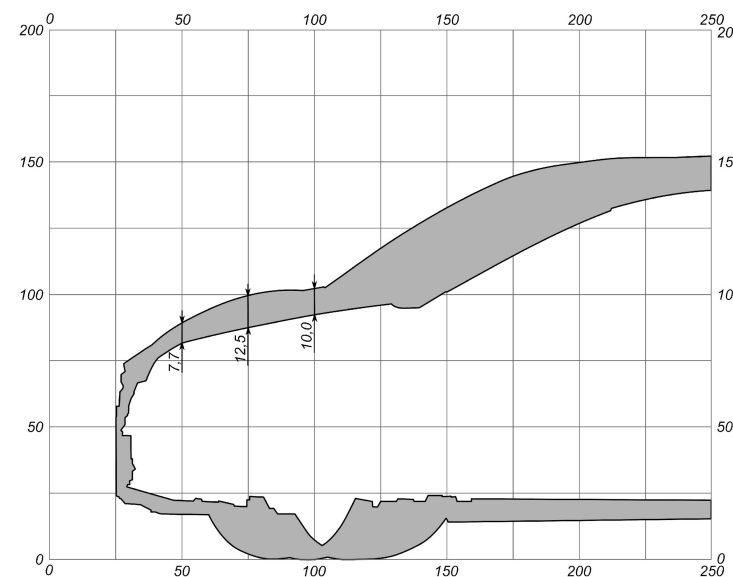
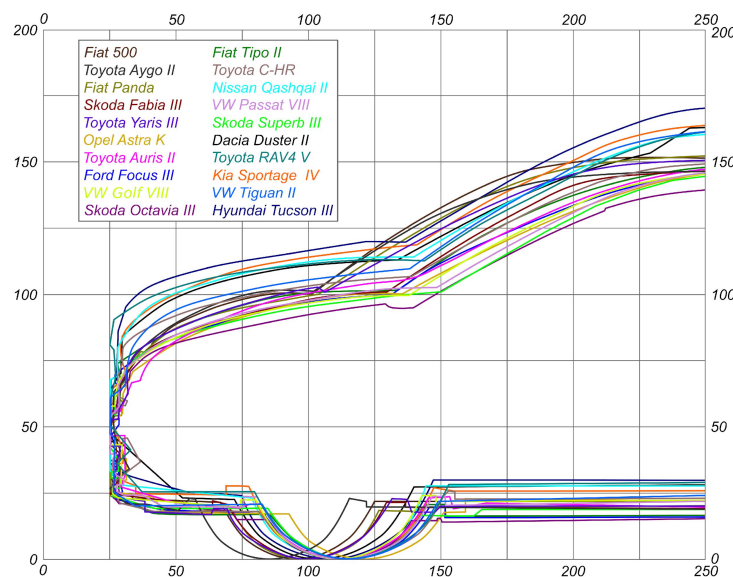
$$ASI(t) = \frac{|\bar{a}_x(t)|}{\hat{a}_x}$$

$$a = a_x = ASI \cdot \hat{a}_x$$

$$x = \frac{V^2}{24 ASI \cdot g}$$

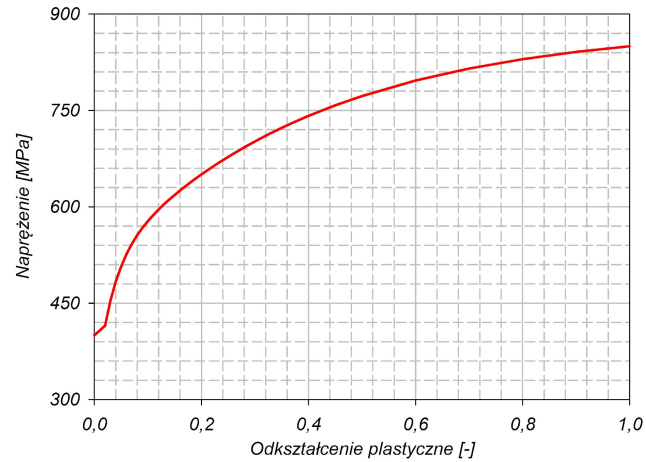


Selection of geometric parameters



Numerical modeling

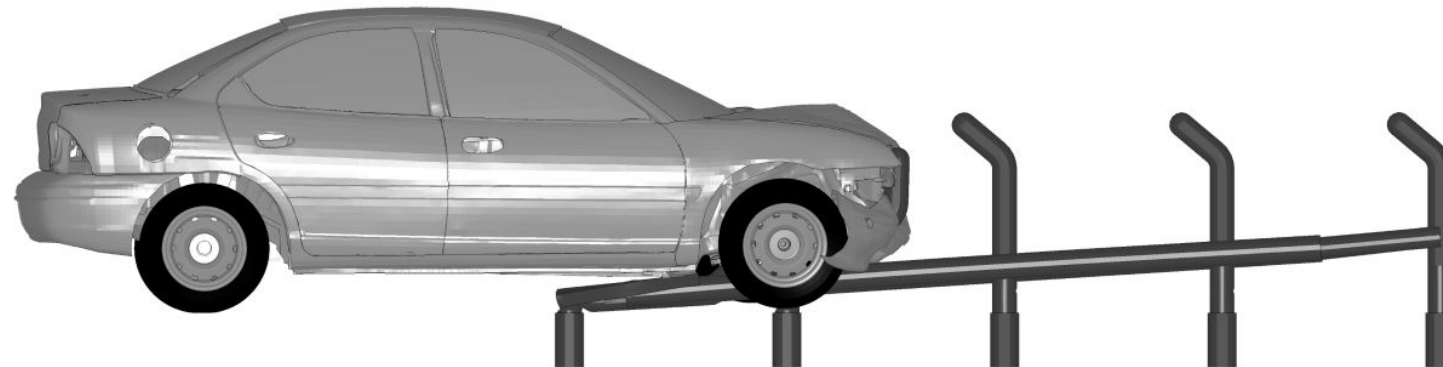
Material modeling



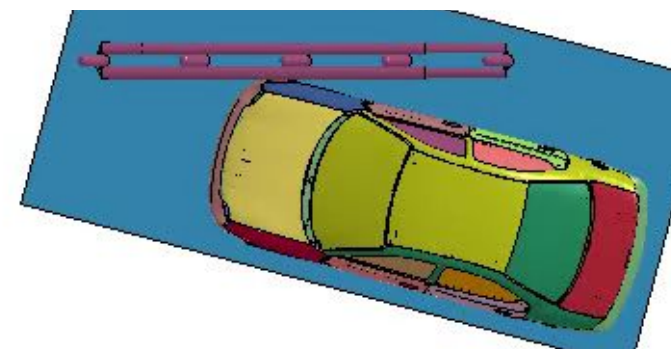
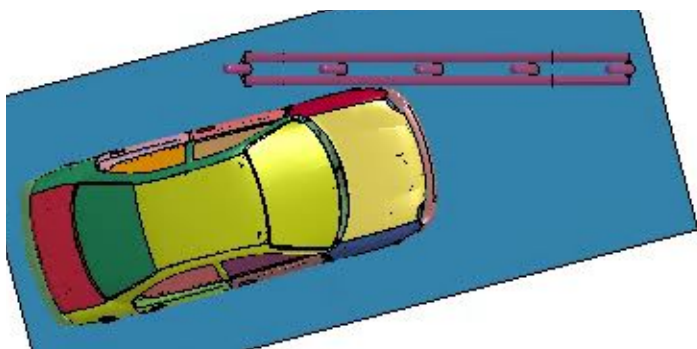
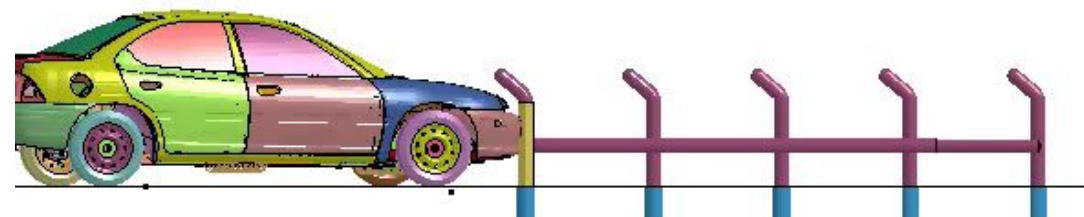
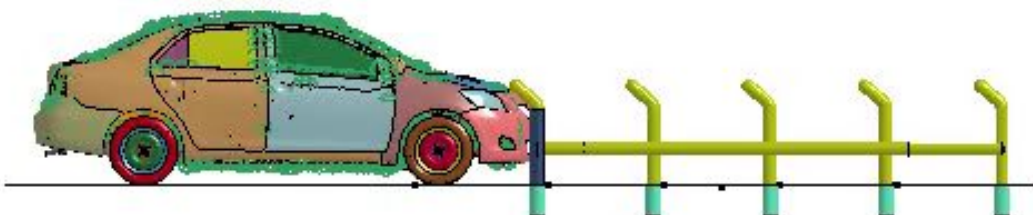
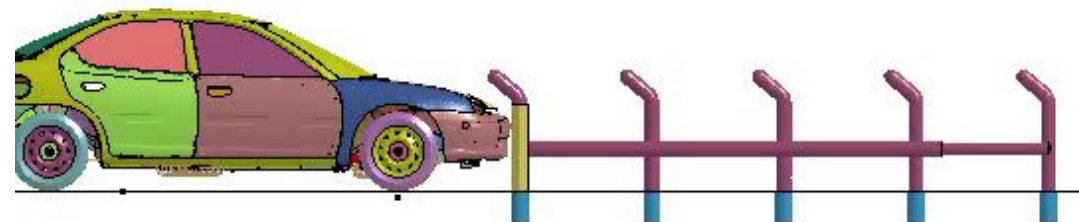
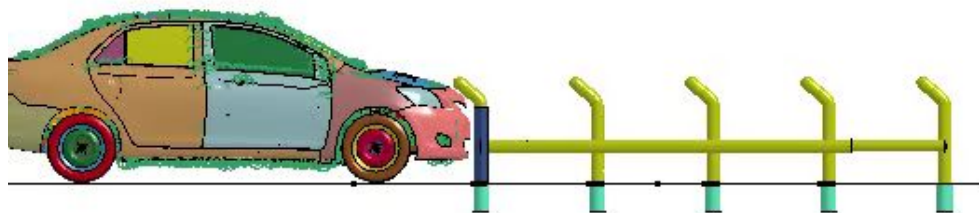
Absorber modeling



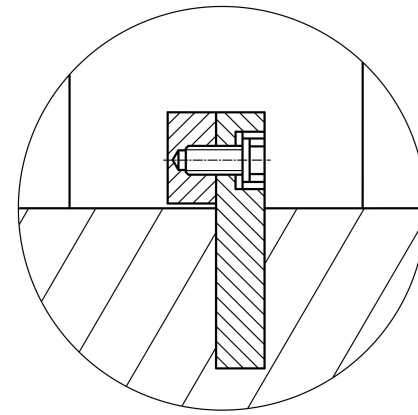
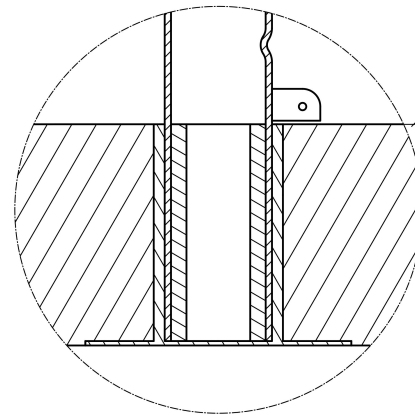
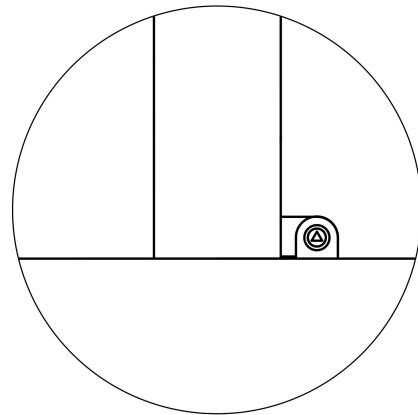
Crash test modeling



Numerical modeling results



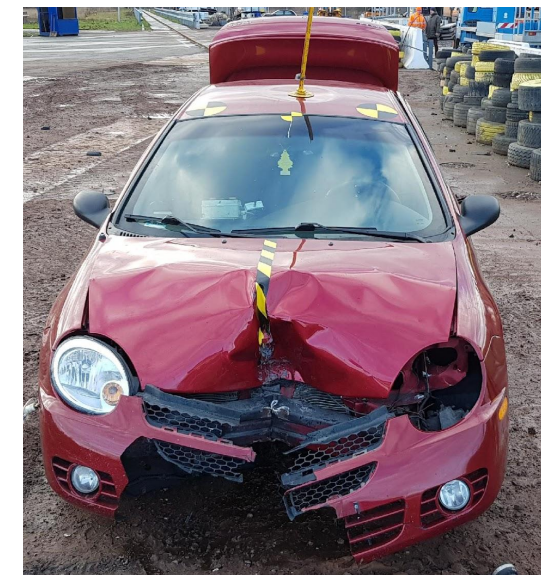
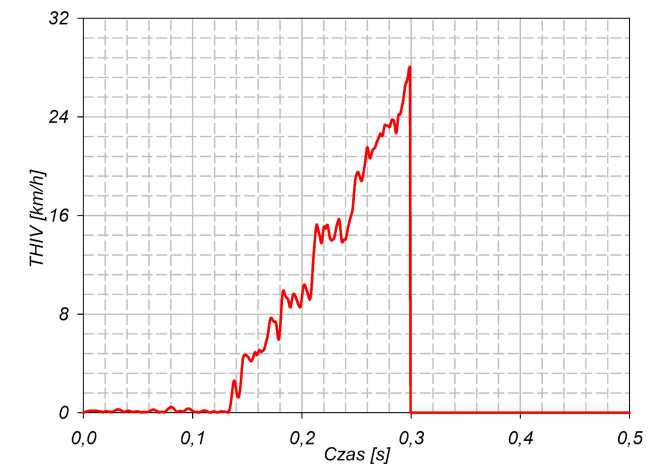
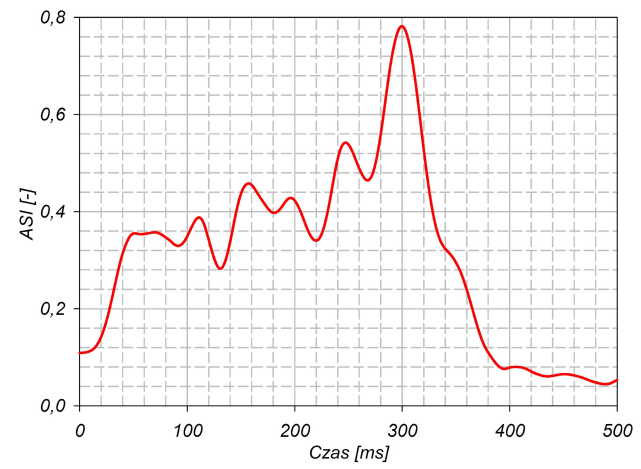
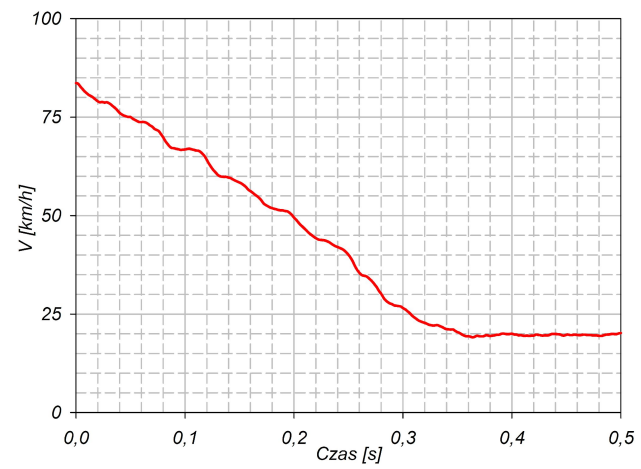
Field test



Field test results



Field test results



Field test results



THANK YOU FOR YOUR ATTENTION



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Faculty of Mechanical Engineering
Military University of Technology

Project title: TubeRoSa – development of an innovative road safety device based on vertical energy absorbers using advanced simulation methods in a virtual environment

Contract number: LIDER/28/0108/L-11/19/NCBR/2020

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Narodowe Centrum Badań i Rozwoju