Title: ***Novel Technologies for Variable Force Energy Absorption Devices for Pedestrian-friendly Front Bumper***

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ABSTRACT
The minimization of injury to pedestrians requires a front bumper to vary its deformation characteristics according to the class and orientation of collision object (eg adult – front facing, child) in order that the peak acceleration of the legform is reduced below thresholds for fracture or joint damage.

It is argued that obstacle identification systems are now in advance of the safety device hardware that could benefit from this highly detailed information – with passive front bumpers being a clear example.

The paper reports a review of the limitations of existing approaches and presents novel force-varying actuation devices. The solutions are presented as two categories:

- passive devices with inherent force-regulation variable in discrete steps
- continuously variable devices with open or closed loop force control

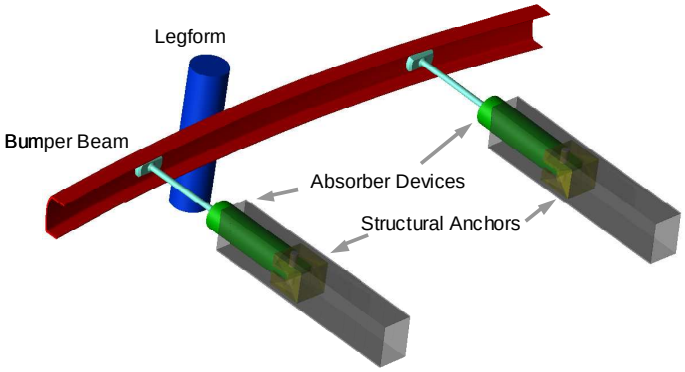
In both cases, selection is possible according to the type of anticipated collision to minimize peak forced by utilization of the entire deformation region available behind the front-end module.

Outline concepts are presented which apply the following approaches:

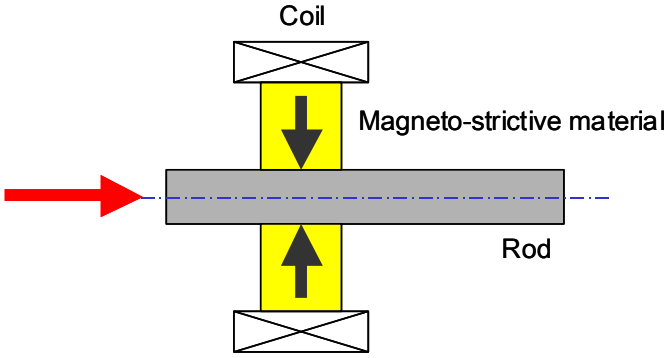
- multiple selectable deformation columns
- multiple selectable hydraulic pistons
- profiled hydraulic piston with multiple selectable discharge elements
- hydraulic modulation with a fast acting pilot valve
- controllable interference fit on moving rod
- magneto-rheological and electro-rheological fluid circuits.

It is anticipated that in addition to simulation, test data will be provided for early prototypes of the preferred concepts.

Selection criteria are discussed and then applied to identify the cost-benefit for each of the concepts within package and mass constraints. The approach provides preferred solutions for devices with discrete fixed load and fully variable characteristics and includes considerations of long-term dormancy and technology maturity.



Front Bumper Bar with Absorbing Devices



Scheme for Magneto-stictive and Pietzo Constriction