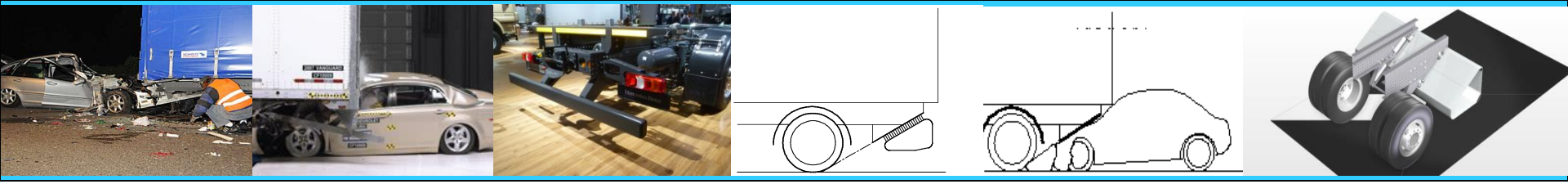

Proposal for an Energy Absorbing Underrun Protection System for Commercial Vehicles

Presentation 05 May 2016

Underride Roundtable at IIHS

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Table of Contents

Motivation to improve the underrun protection

To avoid, at least to reduce consequences of such accidents significantly

Sz-online 03.11.13

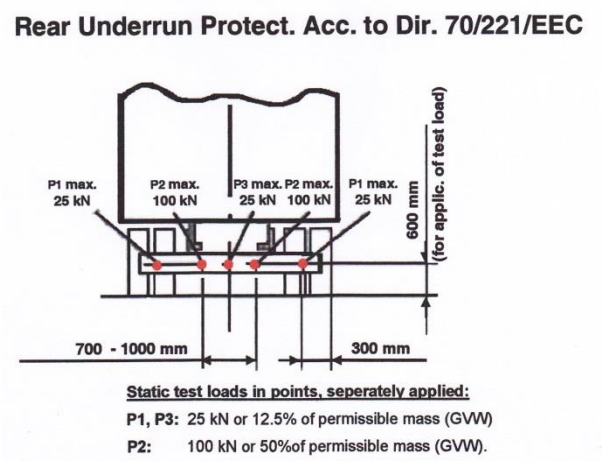
General-Anzeiger 11.05.11: 4 Tote bei Unfall auf der A3

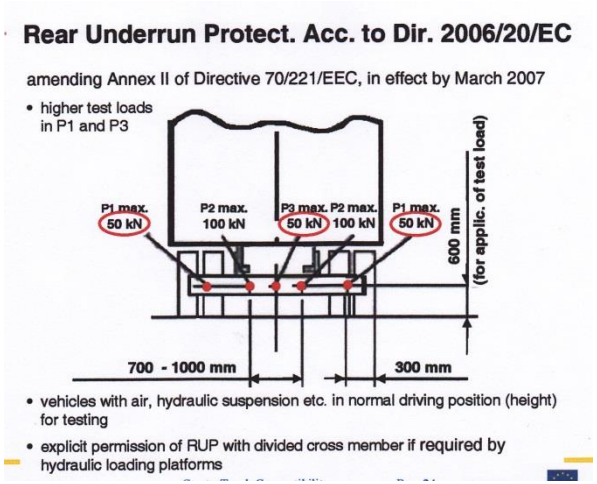
General-Anzeiger 26.04.11: Kombi rast unter einen Laster

Current measures of underrun protection

Current regulations

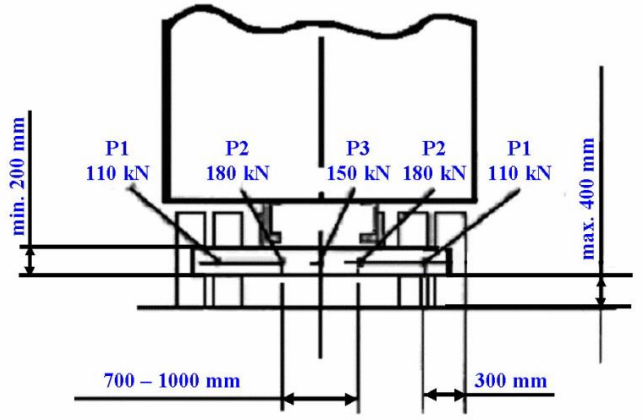
From ECE R-58 via Directive 70/221/EEC, supplemented by Directive 2006/20/EC to…





… **the proposal by EC Study VC-COMPAT:**

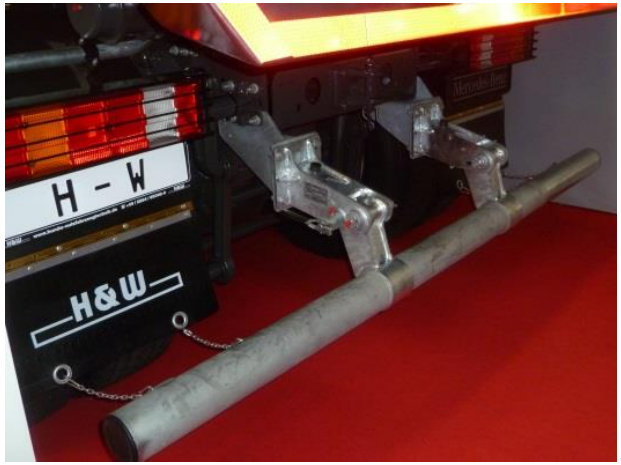
For the rear underrun protection (RUP) systems, as a result of the investigations together with the validation test the performance criteria set in the static test can be given as an advice for a regulation.



Current measures of underrun protection

Examples of presently realized rear underrun protection (RUP) systems

Pictures taken at the ‚IAA für Nutzfahrzeuge' 2012, Hannover, Germany



Criticism of existing underrun protection systems

Tests (ADAC, IIHS etc.) also demonstrate the unsufficiency of existing underrun protection systems

Underride Crashes can be catastrophic for people in passenger vehicles

...but a new Institute analysis of real-world crashes indicates that too often rear guards intended to prevent underride buckle or break away from their trailers – with deadly consequences.

(Ref.: Insurance Institute for Highway Safety Status Report Vol.-46, Nov.2, March1, 2011)

http://www.iihs.org/news/rss/pr030111.html

Criticism of existing underrun protection systems

Recommendation by the ADAC

Fig. A: Test according to the current EC-directive

Fig. B: ADAC recommendation for an improved RUP

ADAC recommendation (Fig. B) is not a real improvement:
the RUP device is too stiff, the passenger car takes over nearly the whole deformation energy.

This cannot be considered as a partnership w.r.t. the crash compatibility between the road-users.

Criticism of existing underrun protection systems

- **Insufficiency of existing underrun protection systems,**
  real accidents and experimental demonstrations confirm it.
- **Since about 50 years no improvement: still the „lateral beam (bumper) technology“,** only debates on proof forces, dimensions, distances etc. (on UNECE WP 29 level).
- **Proof loads only for certain points, parallel to the longitudinal axis only**
  more realistic: energy introduction over the contact area, and also considering lateral loads.
- **The present underrun protection devices are not really energy absorbing systems,** they only have to withstand certain loads (proof loads) and may break, when they are exceeded (only static proof loads!).
- **Crash physics are dynamic processes** (short time physics), not considered up to now for underrun protection systems.
- **Voluntarily, no interest of improvement** by the manufacturers, carriers, insurance companies (required reduction of insurance premiums are not lucrative); sham argument: too high additional costs and mass, no need for further action (industry fulfills requirements)
- **All these aspects have to be considered for future regulation processes!**

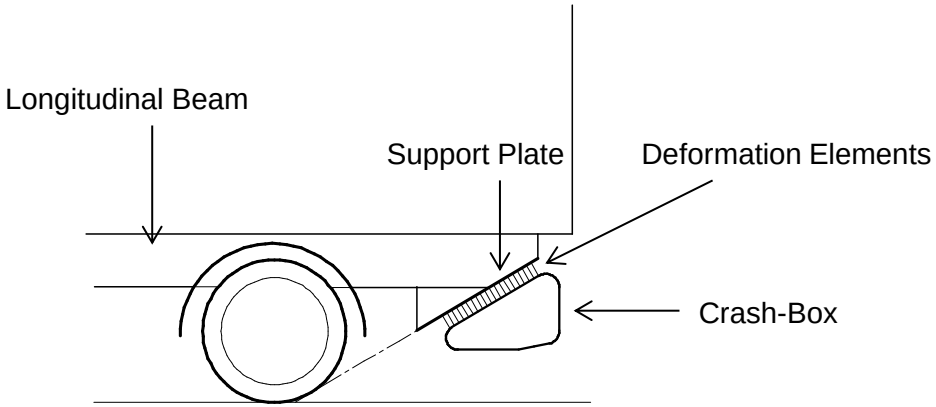
Idea of an improved underrun protection system

Principle of an energy absorbing underrun protection system

Idea bases on the absorption of collision energy by structural deformation and frictional sliding of a wedge-shaped crash box with adjoining deformation elements.

Design, material selection, and dimensioning of the deformation elements can ensure a time-delayed course of energy absorption.

⟶ Considerable reduction of the deceleration forces on passenger and objects.



The load introduction over the contact area, more equally distributed.

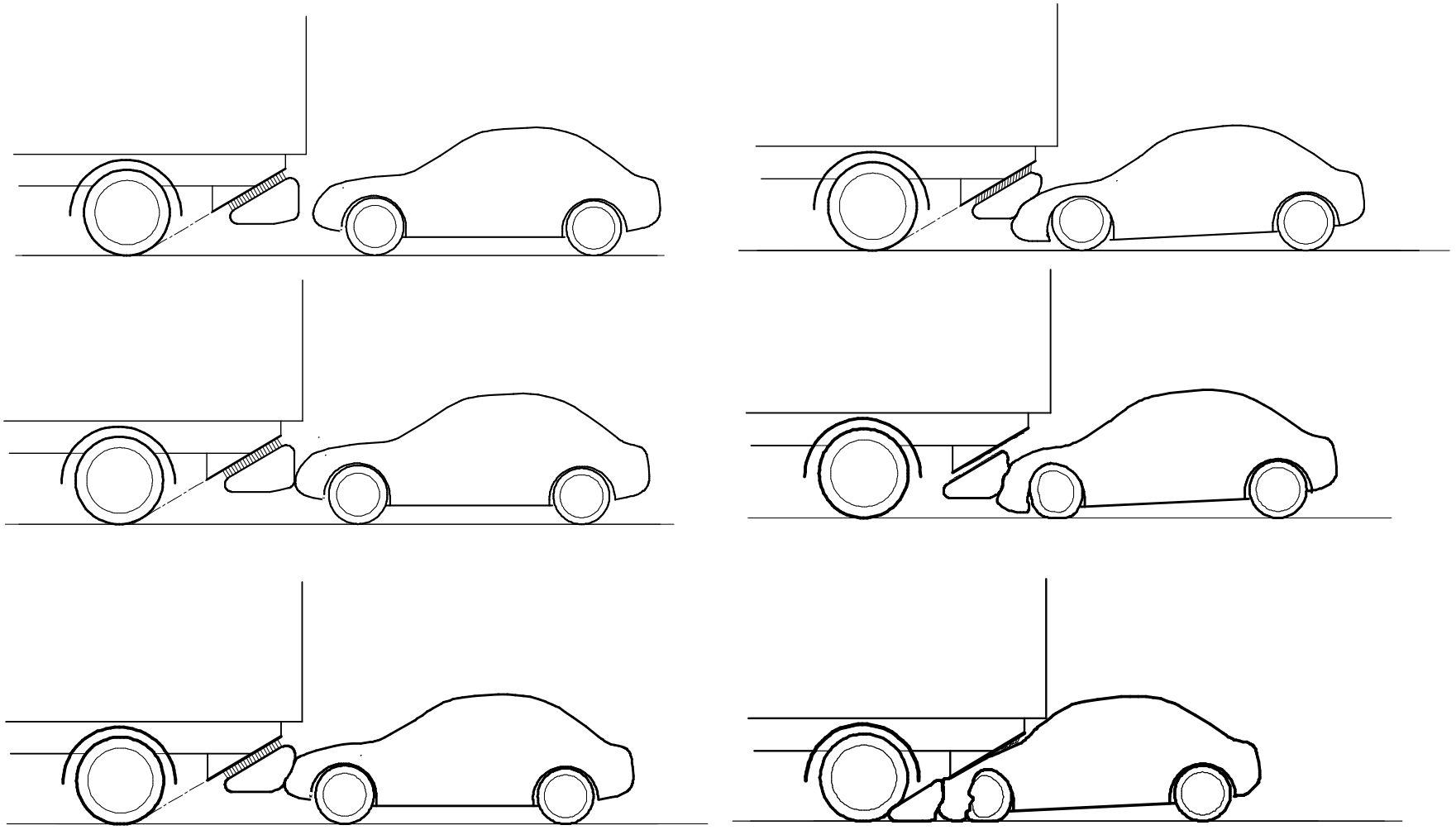
Works also in case of eccentric or oblique crash impact

Crash box stiffness well-balanced over the full width of vehicle

The idea is demonstrated for rear underrun protection (RUP) but is applicable in principle also for front rear underrun protection (FUP).

Idea of an improved underrun protection system

Principle function of the idea



Requirements on an Improved Underrun Protection

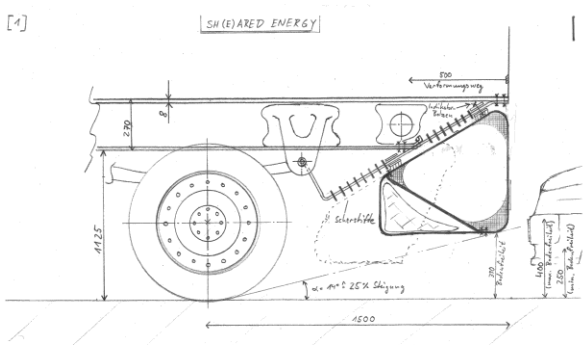
- Absorption of energy in case of crash for commercial vehicles of 7.5 to ≥ 40 t
- Great extend of deformation and displacement of the crash elements
- Limitation of deformation after a certain displacement, over that the deformed crash box may glide along the support plate
- Minimization of deceleration loads of the car driving into the rear
- To ensure that passenger cabin not underrun the rear of a truck
- Guarantee the function under all operational conditions (e.g. eccentric or oblique impact, all weather conditions)
- Maintenance-free
- Mass below 100 kg
- Δ-Costs below 500 €

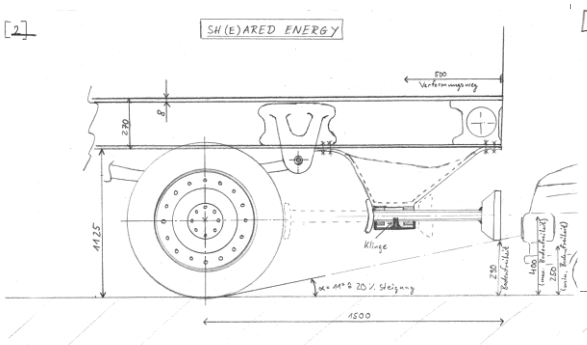
Load assumptions

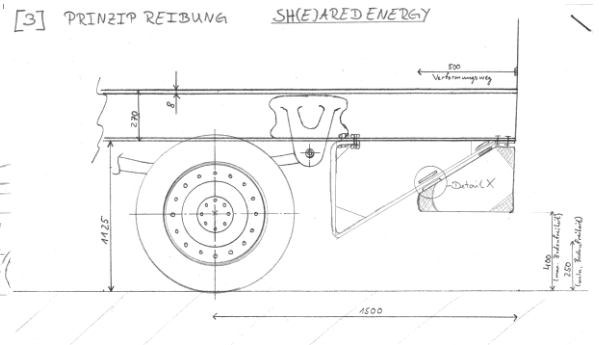
- Mass of the colliding passenger car: m = 2.000 kg
- Velocity of the colliding passenger car: v= 60 km/h
- Corresponding deformation zone of the colliding passenger car: approx. 0.6 m
- Corresponding deformation zone of the crash box of the truck, incl. deformation elements: approx. 0.5 m

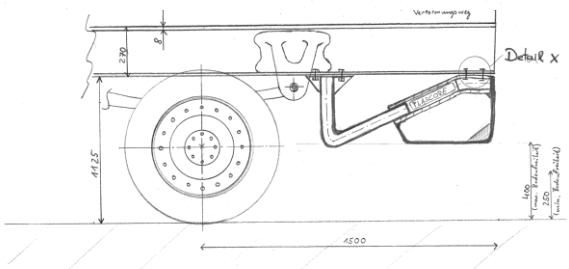
Drawing up of the idea

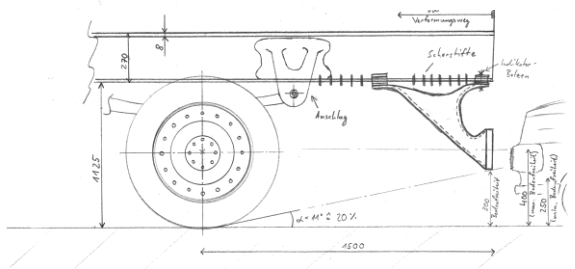
Design solutions

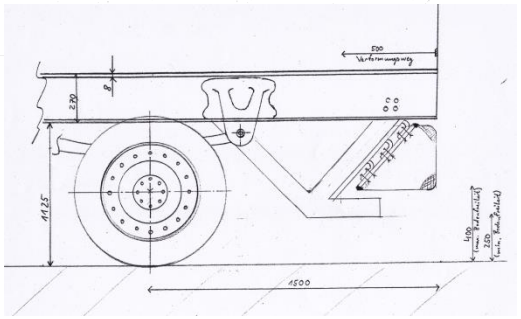


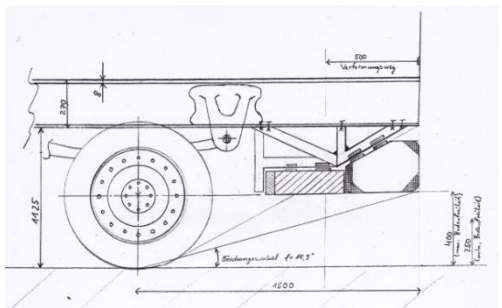


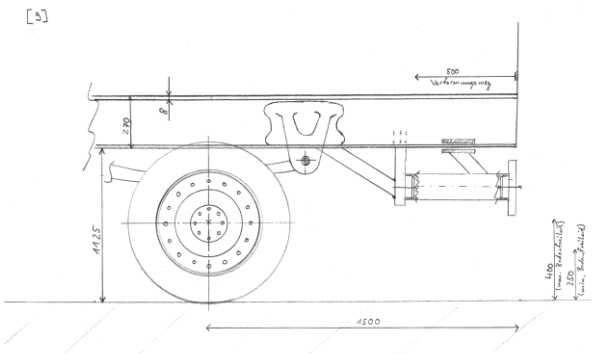


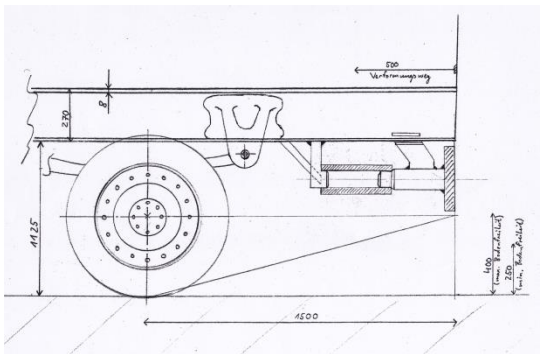






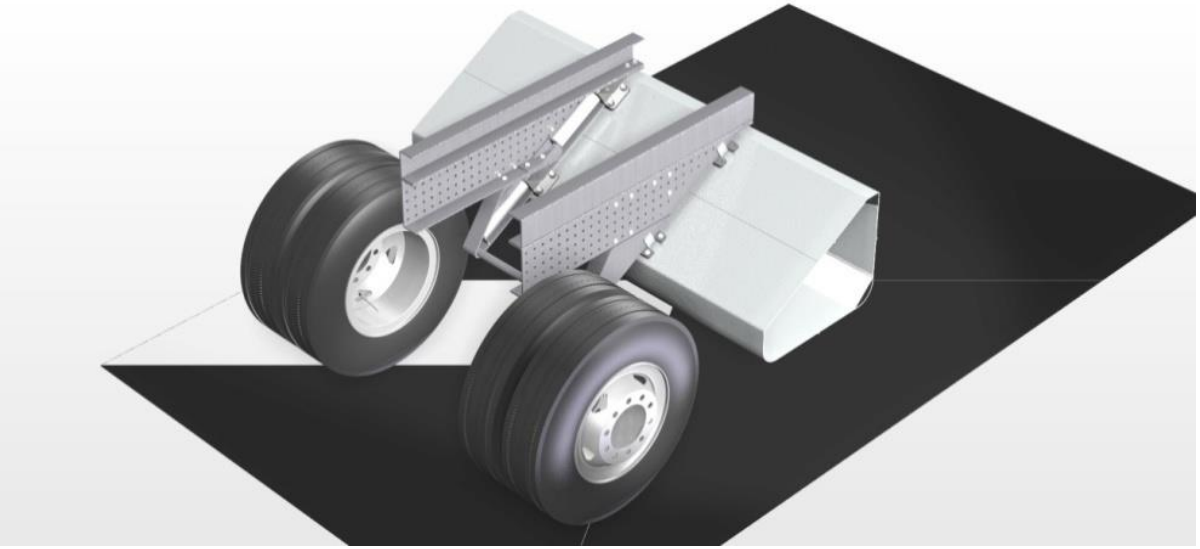


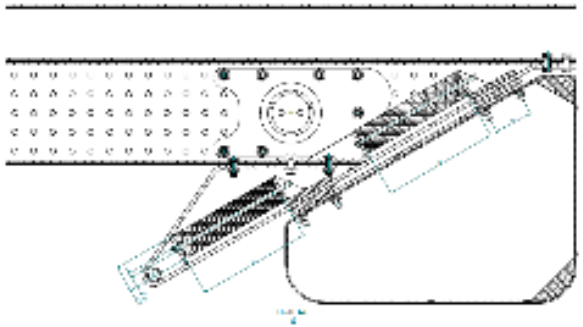


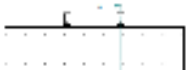


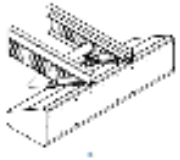
Drawing up of the idea

Layout and design of a selected configuration





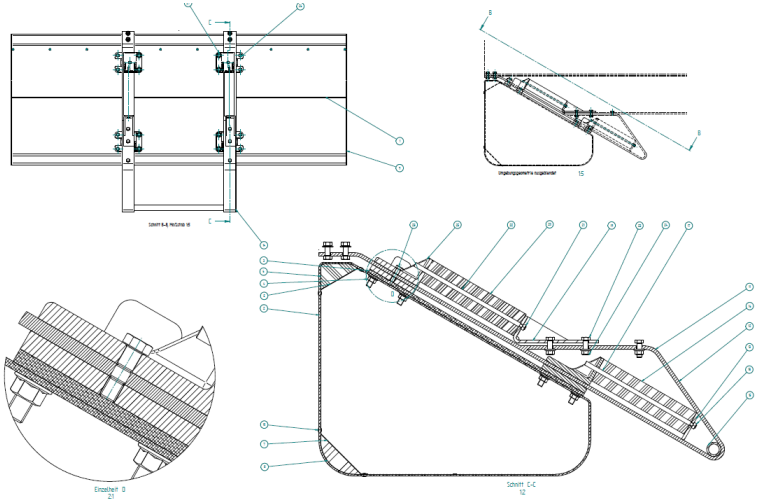


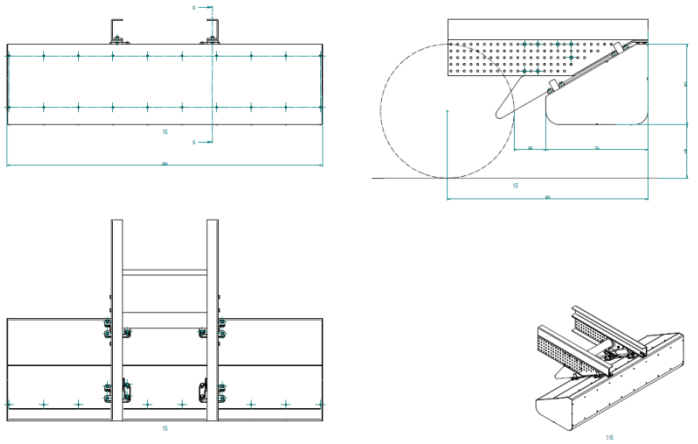


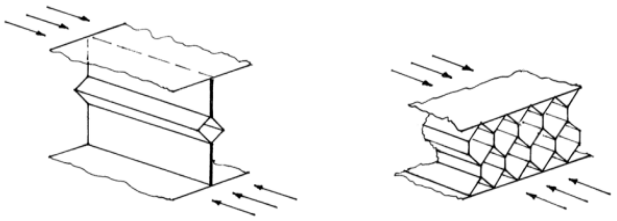
Drawing up of the idea

Dimensioning and mass estimation

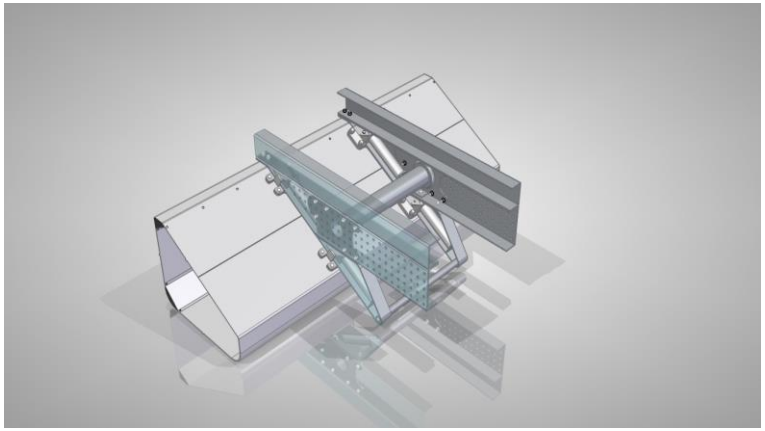
Status: Engineering drawings with dimensions and material selection (parts list) are available







Alternative: shear deformation elements (simplified version to be investigated)



The mass has been estimated with about 150 kg for the selected version, where e.g. the thicknesses of the crash box are still over-dimensioned – further optimization is necessary .

Economical considerations

Incentives for Implementation of an Improved Underrun Protection System

- Reduction of deaths and heavy casualties on road → reduction of human sorrow
  - ► reduction of follow-on costs (benefit for the national economy, e.g. for private and national insurances as well as for rehabilitation measures)
- Less damages
  - ► reduced repair expenditure, less repair costs
- No restriction for implementation/realization: patent application has been withdrawn, all presented concepts are free to use
- Governmental promotion for implementation to be discussed
- Reduction of insurance premiums (maybe governmental regulation required)
- Estimated costs for the proposed RUP can be kept below 500 € Δ-costs, dependent on the series quantity (Δ to the current protection systems with separate support beam for the rear lights)

Message

Energy absorbing underrun protection crash structures on commercial vehicles have to become standard, as they are on passenger cars for decades.

Further proposed actions

- How to implement the principle of energy absorbing underrun protection systems into guidelines/standards/legal regulations
- To demonstrate the feasibility of the principle by a project
- Finding out of potential partners for a project and the financing of it
- Estimation of economical aspects
- Identification of national/international responsibilities to promote the principle of an energy absorbing improved underrun protection system for commercial vehicles
- Contribution to WP 29 of UNECE

Proposal for a project (first approach):

A project to proof the feasibility of the improved underrun protection system

Phase 1 (theoretical tasks, partly carried out as demonstrated)

- Requirements and load assumptions
- Identification of design solutions
- Layout and design of a selected reference configuration
- Dimensioning and construction
- Numerical crash simulation (e.g. PAM-Crash calculation – an iterative process)
- Consideration of economical aspects (first approach)
- Evaluation incl. recommendations for the next phase

Proposal for a project (first approach):

Phase 2 (experimental activities)

- Preparation of a test procedure
- Establishment of workshop drawings for test models
- Manufacture of test models
- Performance of crash tests
- Evaluation of the crash tests
- Final design and dimensioning of an energy absorbing underrun protection system (operational system)
- Working out a standardization process
- Consideration of legal aspects
- Evaluation from economical point of view
- Final Report and presentations

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