

# TUBE ABSORBER OF PASSENGER COACHES IN A COLLISION KINETIC ENERGY

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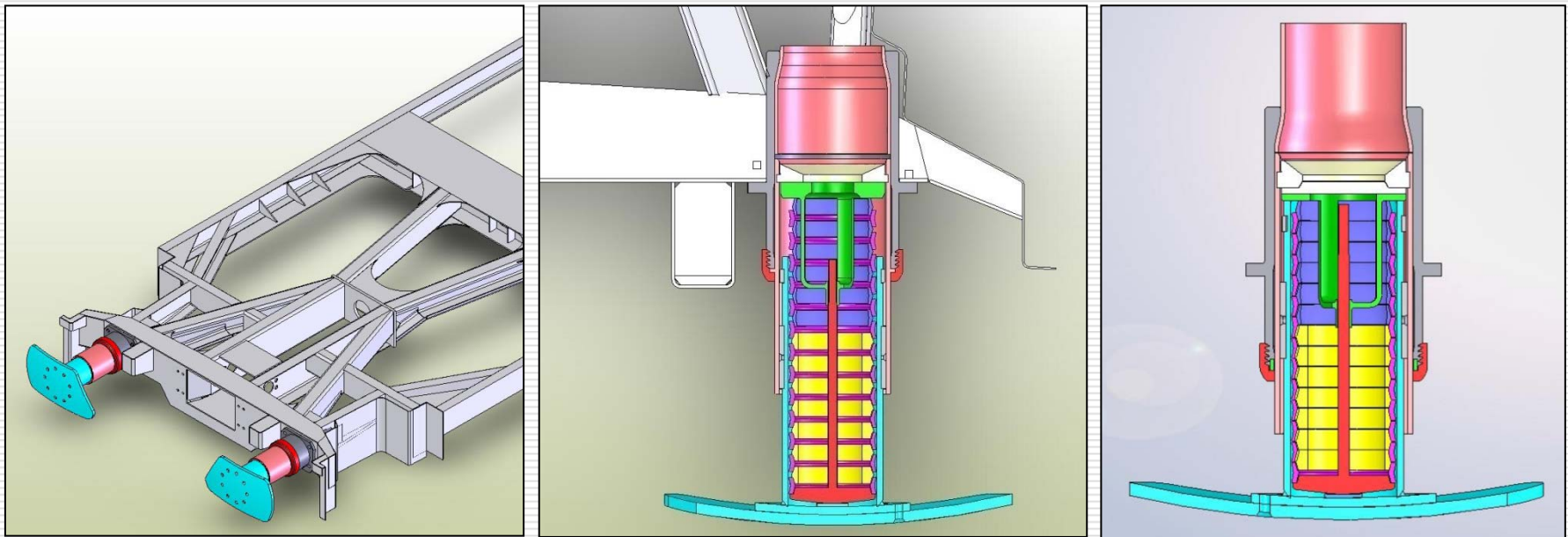
(Faculty of Technology and Metallurgy, Belgrade, Serbia)

**Snezana Golubovic**

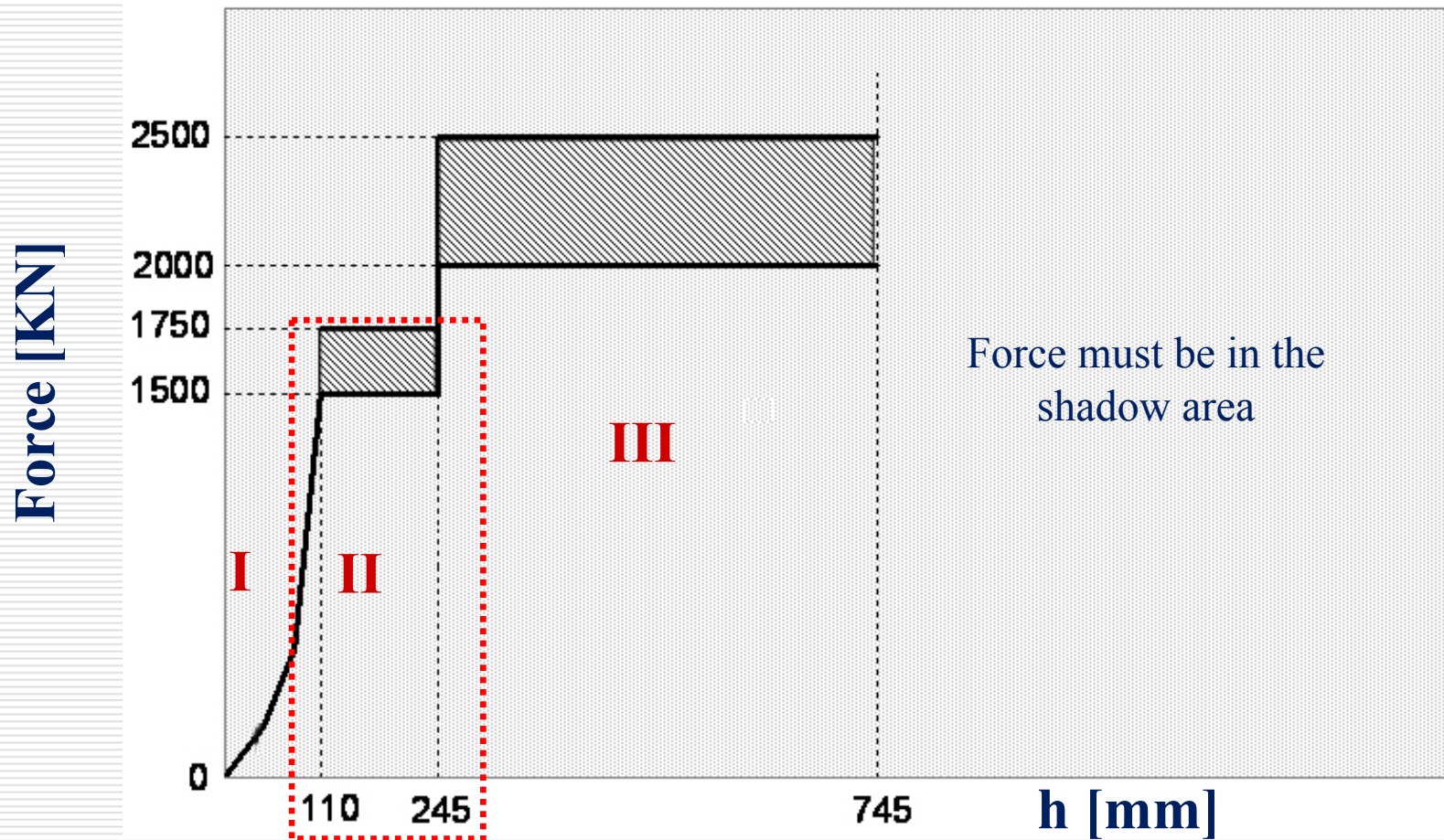
(Faculty of Mechanical Engineering, Belgrade, Serbia)

## *Passive safety*

Purpose of passive protection is to minimize the collision consequences.

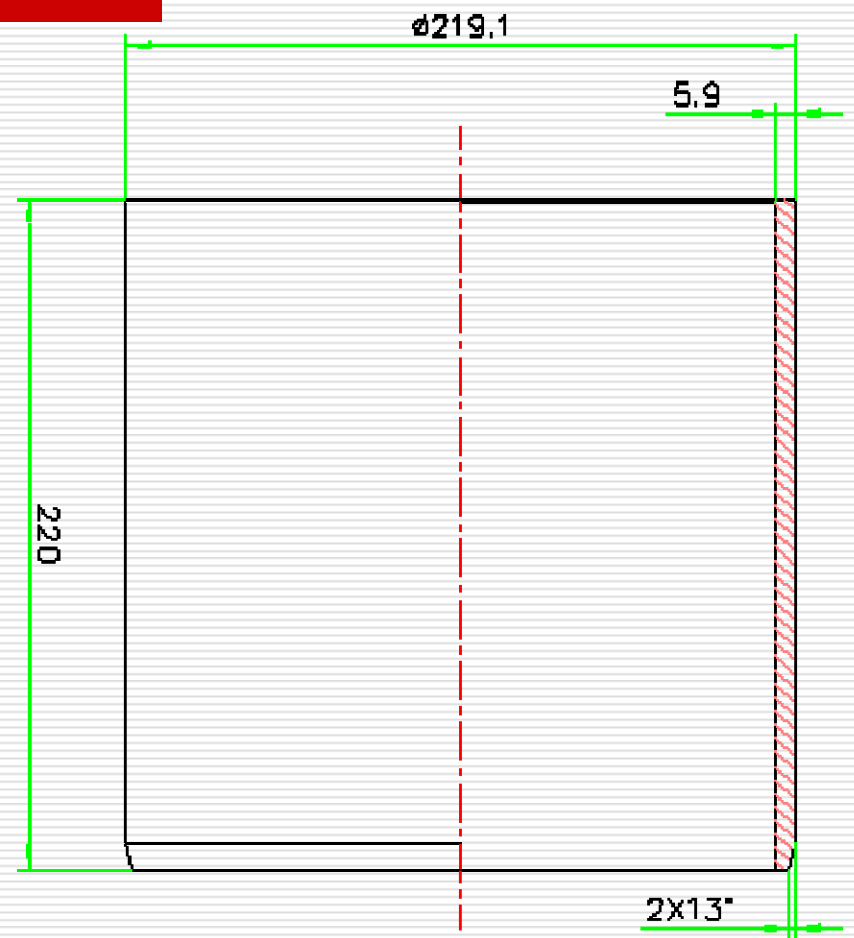


## *Deformation steps (ORE B165)*



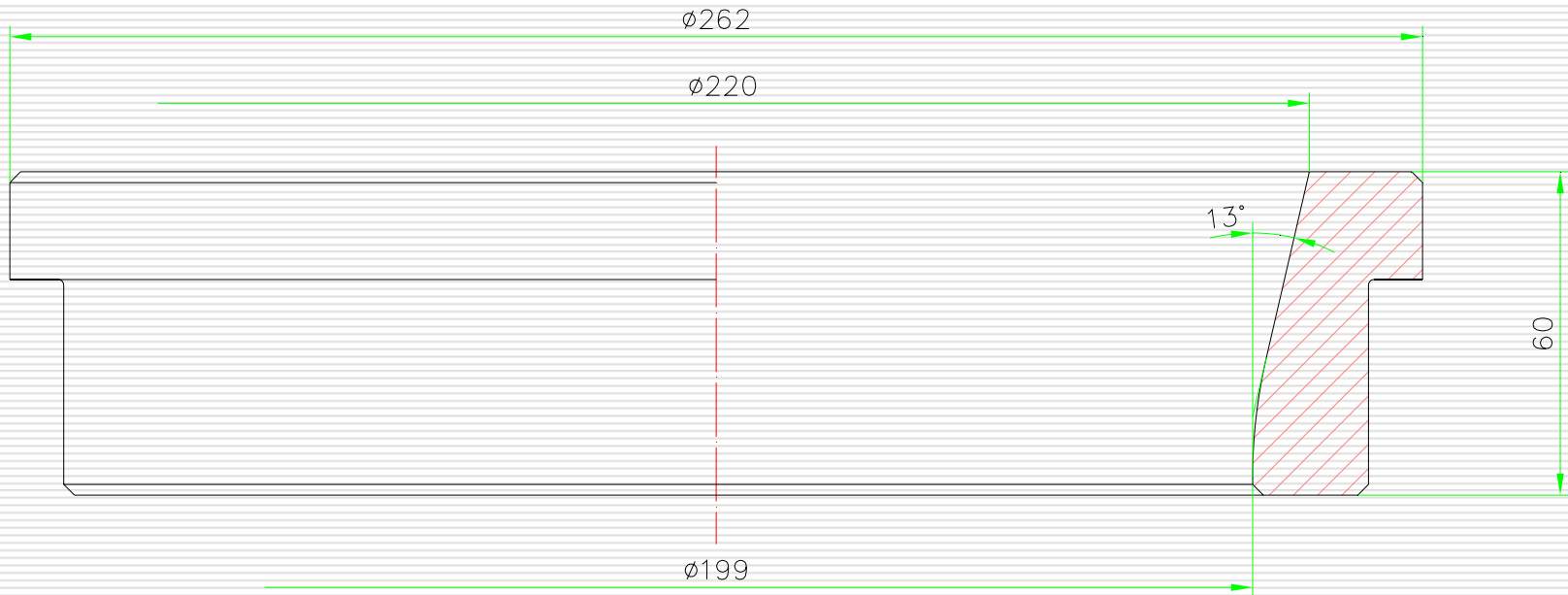
## *Dimensions of the seamless tube*

- JUS C.B5.221
- material steel P235T1
- $\text{Ø}219.1 \times 5.9 \times 220 \text{mm}$



## *Dimensions of the ring*

- material steel C45
- $\text{Ø}220/\text{Ø}199/13 \text{ \#}$  height of 60 mm.



## *Experiment - Quasi-static load on pressure*

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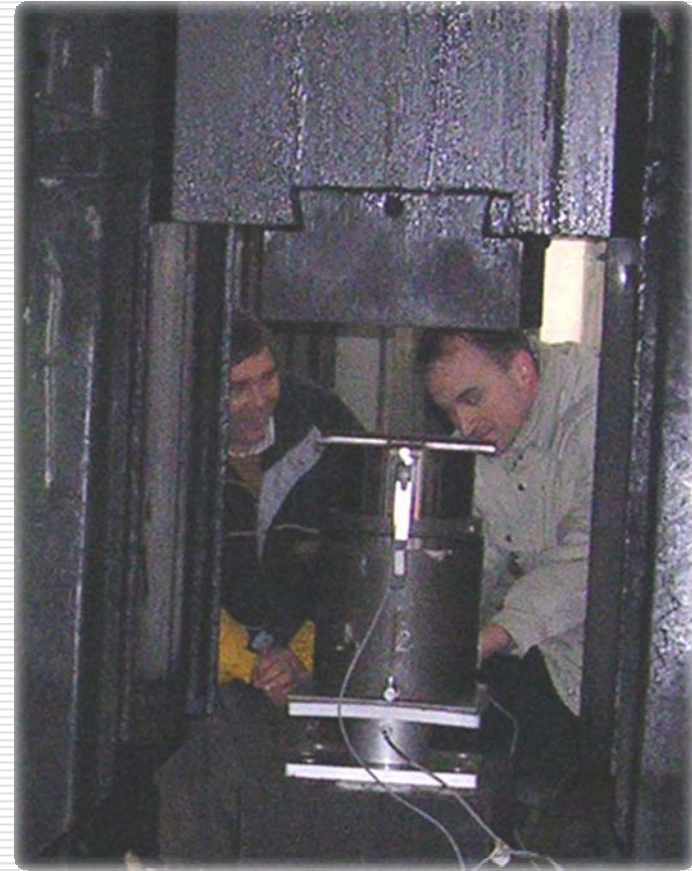
Hydraulic press **LITOSTROJ**  
with maximal force of **2500 KN**.



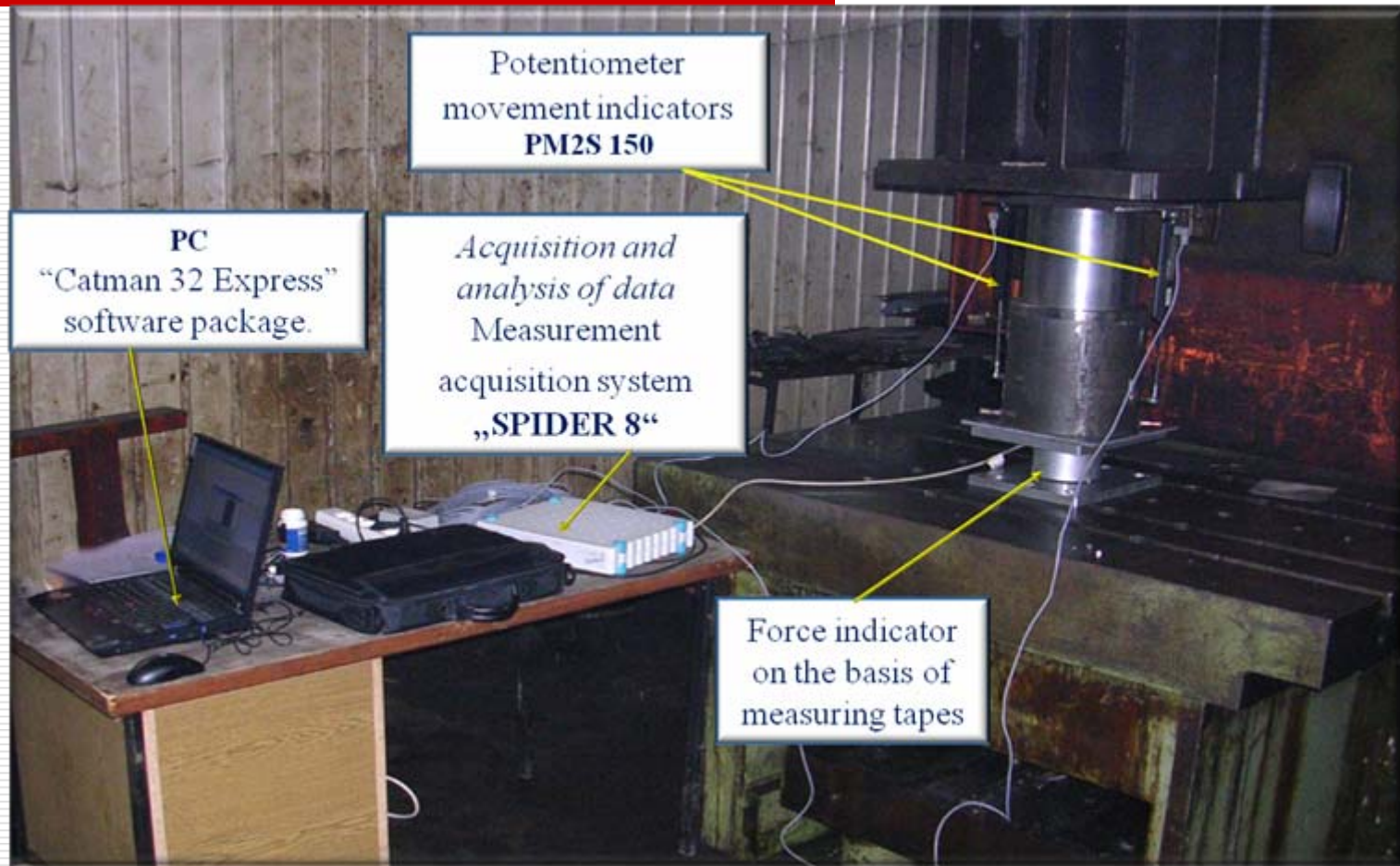
## *Experiment - Dynamic (impact) load*

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Pneumatic hammer **HUTA ZYGMUNT TYPE 6300B** on which maximal work of **70 KJ** can be realized.



## *Equipment*



## *Quasi-static investigation*

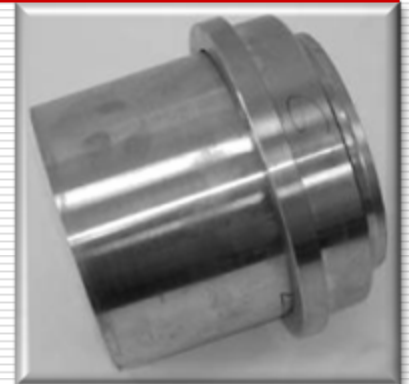
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Quasi-static investigations were performed in two phases:

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In the **first** experimental phase, tubes of all absorption couples were compressed approximately 70mm into the ring, with aim to form absorption couple.

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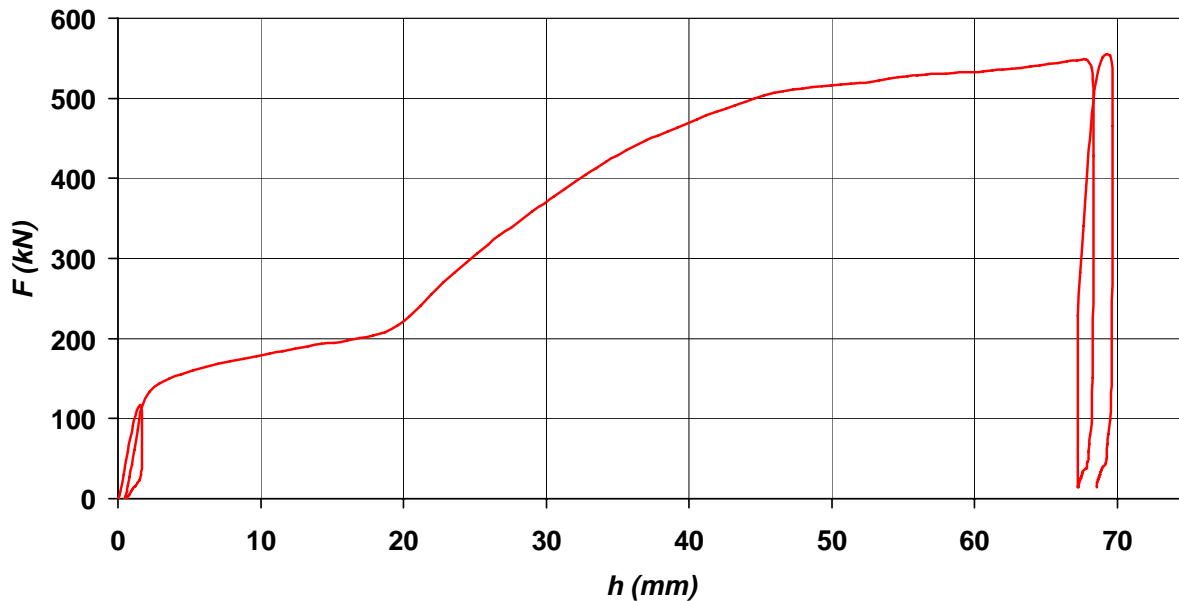
In the **second** experimental phase (*phase of impact energy absorption*), absorption couples were loaded on a press, i.e. hammer where the tube was compressed an additional 105 mm into the ring.

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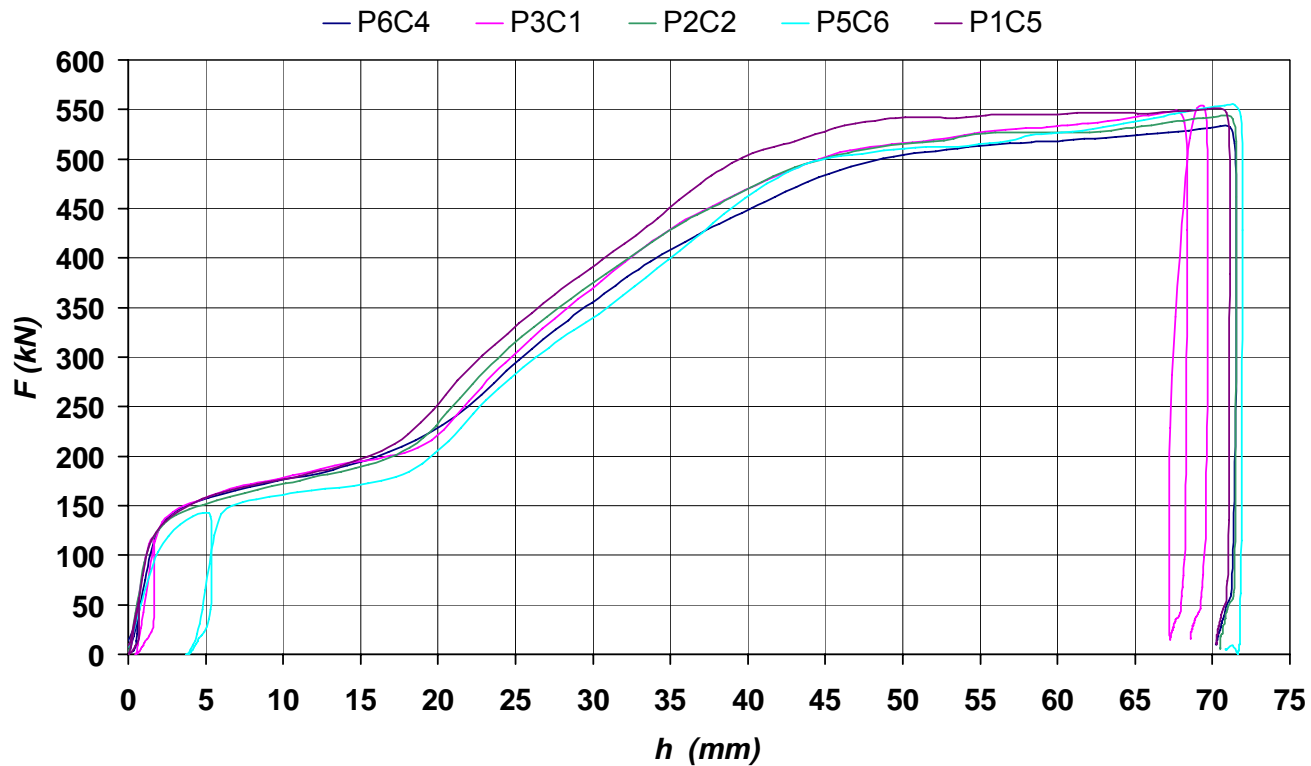
## *Results : Pre-strain phase - Quasi-static investigations*

The dependence is characterized by an increase in force in the whole investigated range and also presence of hysteresis at the beginning and end of the test. Occurrence of hysteresis is the consequence of manual control of the press.



## *Results : Pre-strain phase - Quasi-static investigations*

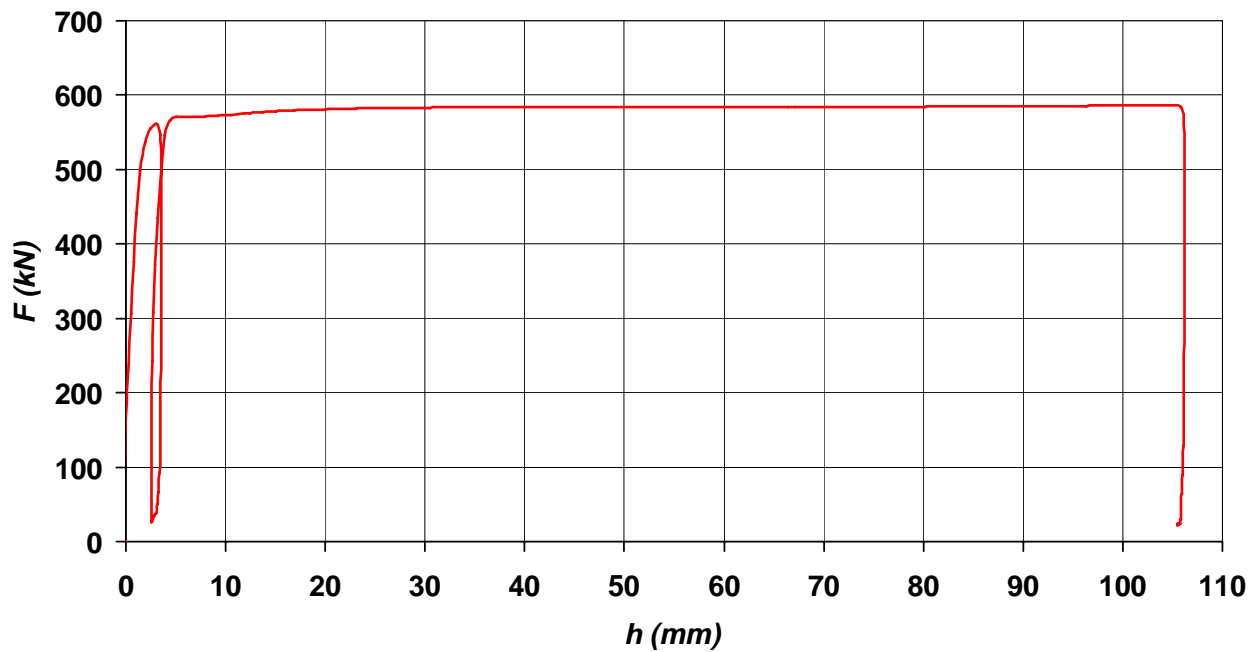
Such behavior was registered in all investigated samples, with small deviations.



## Results

### *Impact energy absorption phase - Quasi-static investigations*

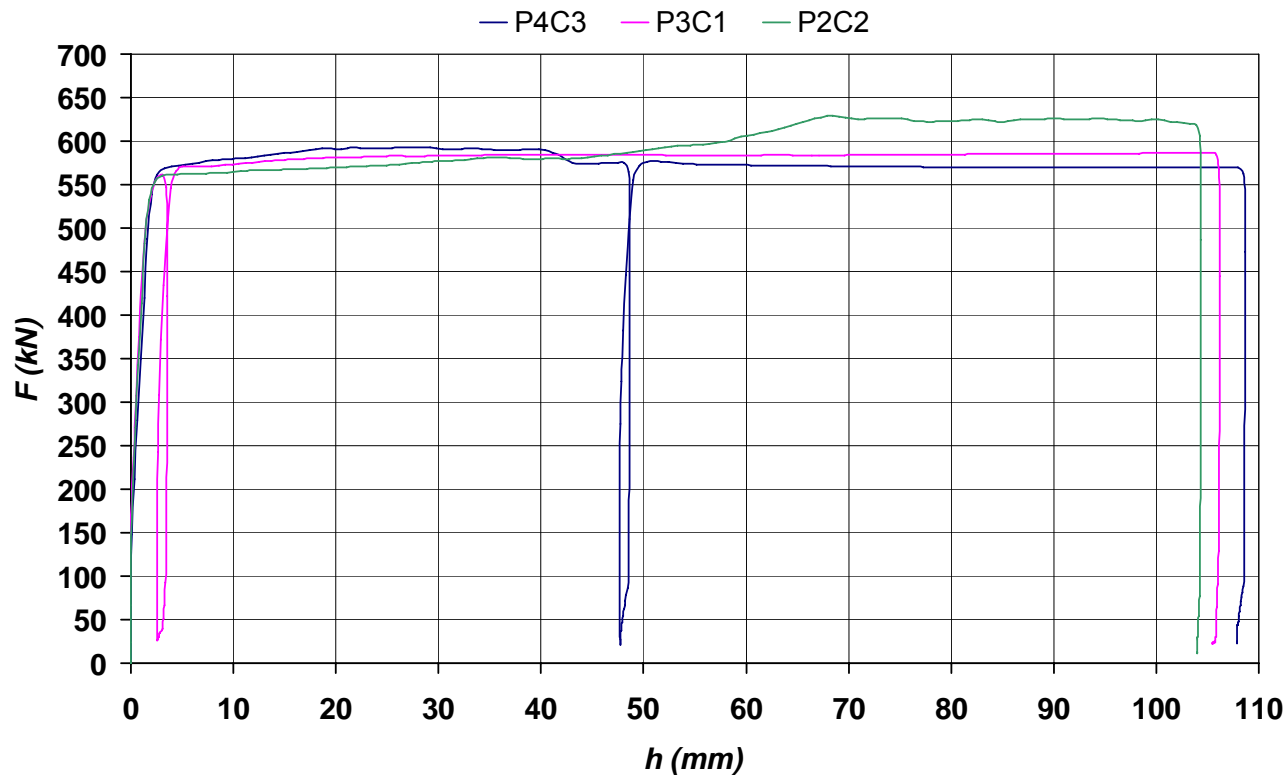
The dependence is characterized by an approximately constant force value in the whole investigated region (for the distance of  $\approx 105\text{mm}$ ) and the presence of hysteresis at the start of the test.



# Results

## Impact energy absorption phase - Quasi-static investigations

Such behavior was registered in all investigated samples, with small deviations.

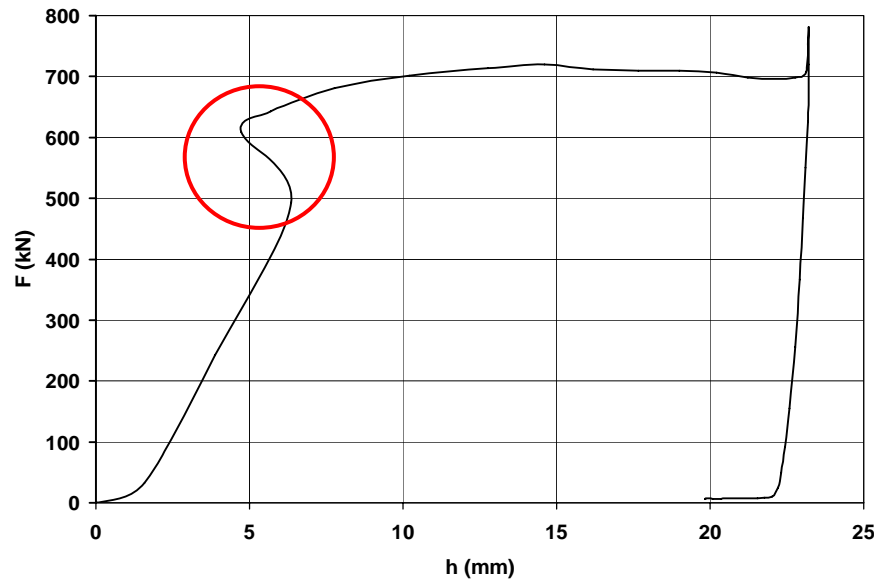


## Results

### *Impact energy absorption phase- Dynamic investigation*

The enclosed diagram shows that the force increases linearly until the value of  $\approx 500\text{kN}$  and distance  $\approx 7\text{mm}$  after which with certain deviations the force increases significantly less sharply for the  $\approx 20\text{mm}$  distance.

The deviation in the force (encircled in red) is due to the limitations of the indicators. Induction indicators are better for measuring distances for fast deformation rates.



## *Evaluation parameters*

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Parameters according to which an evaluation of the suitability of this type of element for energy absorption was given:

- *maximal force –  $F_{max}$*
- *average force –  $F_{av}$  and*
- *compression work –  $W$ .*

## *Characteristic parameters*

Parameters of significance for evaluating elements for energy absorption of the collision of passenger coaches obtained in the second phase of quasi-static and dynamic investigations.

No	Investigation type	Average value	$F_{\max}$ (kN)	$F_{sr}$ (kN)	$F_{\max}/F_{sr}$ (kN)	h (mm)	W (kJ)
1	Quasi-static	$x_{1-3}$	603.08	585.86	1.03	105	61.52
2	Dynamic	$x_4$	719.96	562.12	1.28	20	11.24

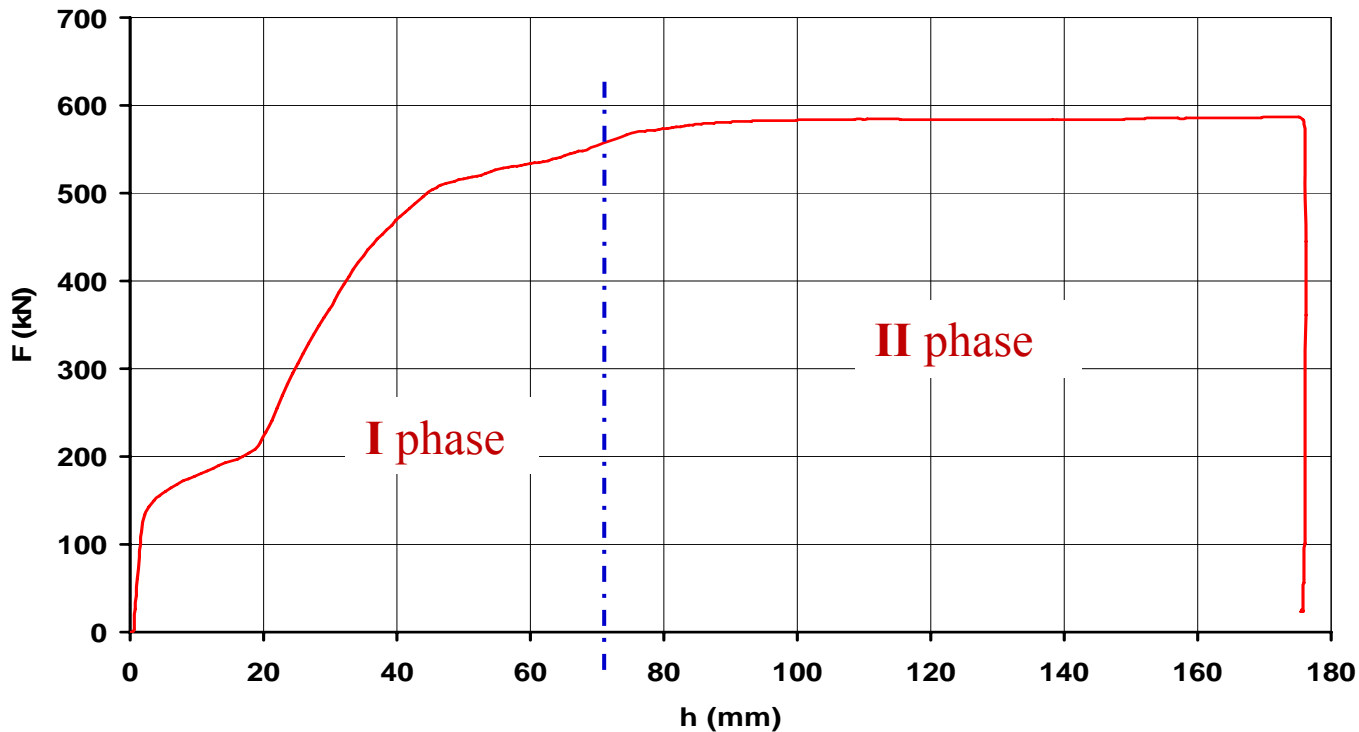
## *Characteristic parameters*

The experimentally obtained values of the force and work function are somewhat lower than the defined ones so a correction of dimensions of elements of the absorption couple or joining of phase I and II of the experiment are necessary.

No	Investigation type	W (kJ) (From this paper)	W (kJ) (Phase I+II)	W (kJ) (Defined)
1	Quasi-static	61,52	≈ 81	101,2-118.1

## *Experimental phases I + II*

Joining of phases I and II would utilize the pre-strain energy for absorption of collision energy and that way come closer to the set requirements.



## *Conclusion*

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Having in mind that a somewhat lower force and thus energy values from the set ones were obtained it is necessary to perform certain modifications of the absorption elements:

- *correction of some dimensions of absorption elements or*
- *correction of material.*

The space for absorber installation is very limited increase of dimensions is not possible.

After these modifications are made, experiments are planned using a CRASH TEST enabling a final evaluation of this type of absorption elements.

*This is our target*

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*Thank you for your attention!*