# EXPERT OPINION
## on the master thesis titled
## Analysis of Material Deformation Response to Dynamic Tensile Tests

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The master thesis deals with a determination of dynamic behaviour of material of components of rail vehicles by using dynamic tensile tests. The behaviour of materials under high strain rates is generally different than during static loading. Today, it is mandatory to prove a crashworthiness of the vehicles and it is also required by European Standard (EN 15227). Therefore, the knowledge of the material dynamic behaviour is very important and necessary for designing of new rail vehicles. From this point of view the topic of the thesis is very timely and demanding.

The first part of the thesis (chapter 2) deals with a current state of knowledge regarding dynamic tensile tests. Chapters 2.1 and 2.2 describe the test principles and current dynamic test systems. These chapters also mention specific problems regarding the dynamic testing (e.g. deformation measurement or clamping of a test specimen). Author also references to the European Standard EN ISO 26203-1 that deals with the dynamic tests. Chapter 2.3 describes principles of material dynamic strengthening. The second part of the thesis (chapters 3 to 5) deals with experiments that have been conducted by the author. The aim of the experiments was to analyze a strain rate influence on an intensity of the material deformation strengthening. Chapter 3 describes the equipment used for the experiments (a pendulum impact tester, specimens, strain gauges, amplifier, AD converter and logging software) together with its main parameters. Chapter 4 describes a method of experiments that consists of a preparation of the specimens (together with their instrumentation with strain gauges) and their static calibration, mounting the specimens into the impact tester and application of the dynamic tests. Chapter 5 describes the results of the experiments which is followed by chapter 6 with conclusions and recommendations.

The experiments were conducted with 11 specimens that differ by a position of the strain gauge (in order to determine a line between plastic and elastic deformation). Results from 6 specimens are presented. Measurement on the rest of the specimens was not successful. As a result, the time histories of forces (evaluated from strain gauge measurement) for each specimen are presented. From these time histories the material strengthening (max. reached force) and presence of a plastic deformation (residual force) is evaluated.

The thesis contributes to the problem of material dynamic behaviour especially by a development of the test method for evaluation the intensity of dynamic strengthening and presence of a plastic deformation. Regarding the results presented in the thesis – unfortunately they are obtained from a quite small number of specimens. The tests should be repeated with the specimens with the same position of strain gauges in order to check the repeatability of the results.

Presentation of work is good, it has got 53 pages and includes many figures that improve understanding of the text or shows the measured data or evaluated results. However, the text is in some cases too brief – more detailed explanation would be helpful (e.g. fig. 2.2, fig. 4.1 – what are the widths of the neck, explanation why these dimensions).
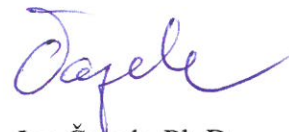
I have following questions:

- Strain gauges – what length of grid was used? Why this length? How could the length influence the results?

- Measured time-force diagrams: the peak from which the max. force is evaluated is a very short-time. Is the chosen sampling frequency high enough to get reliable results of max. force? Specimen 5 (fig. 5.3) – max. force is constant for a certain time, why?

- It is stated that it is important to determine the material properties for a certain strain rate. What values of strain rates were achieved during the dynamic tests presented in the thesis? Is it possible to evaluate (or at least to estimate) it?

Conclusion:

The author meets the requirements on the master thesis. According to a range and a quality of the thesis I give a mark:

**„Very good"**

Praha, 1ˢᵗ June, 2015                                          Ing. Jan Čapek, Ph.D.