University
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Supervisor Review of Master Thesis

„Theoretical and Experimental Analysis of Flexicoil Helical Spring Stress"

by Eren BALABAN

The presented master thesis is especially concerned to computational analysis of mechanical properties of helical spring in condition of its lateral loading. The thesis content 80 text pages.

In the introduction chapter author presents the studied publications that are concerned to issue of computational analysis of flexicoil springs. Next two chapters briefly deal with basics of railway vehicle suspension. Some information in these chapters is not correct and the presented two figures should be more sophisticated.

The fourth chapter is concerned to mechanical properties of coil spring in general; the fifth chapter deals with properties of flexicoil springs. Author utilizes several publications for presenting some mechanical properties by figures with appropriate reference but he has not introduced references to equations. Some equations are not explained in sufficient detail and some of them seem even incorrect.

Sixth chapter presents examples of using flexicoil springs in secondary suspension at the representative modern bogies. The technical description of presented bogies should be more extensive. Repeatedly there are some technical mistakes in this chapter. The seventh chapter briefly describes the carried out experiment, but author forgot to mention that he did not organized the measurement. For this thesis author only use the experimental results. The description of strain gauges is not sufficient, presented figure should be completed by other view.

The main task of this thesis, computational analysis of flexicoil spring deformation, is presented in chapter 8. In the first part author briefly and insufficiently describes the computational model. I missed here appropriate figures to description of FEM especially in its critical places. The form of creation of FEM is very important and influence results. From the evaluation there is noticeable, that model of contact is not so accurate – the difference between calculation and experimental results of stress of strain gauges R1 and R11 is too high. The comparison of results of strain gauge R4 shows also insufficient accuracy of the model. The results show in general that the accuracy of the FEM is depended on accuracy of spring shape which is in experiment influenced by manufacturing inaccuracy.

Before the end of my review I introduce selection of basic critical remarks:

- List of symbols does not contain units, it is not alphabetically arranged and not complete.
- In some cases references to literature and figures are disorganized (e.g. page 15 or 43).
- Incorrect denomination for unit of mechanical stress – M**p**a (p. 15).
- Air is not used as suspension element but as suspension medium.
- For railway vehicles, 1 passive turn is used usually only for flexicoil springs.

- Describing of design concept of spring misses appropriate equations.
- Equation (14) does not correspond to other equations.
- Equation (23) does not correspond to equation (22).
- I do not agree with formulation that flexicoil springs reduces forces between wheel and rail.
- I missed appropriate more detailed explanation and figures for equations on the page 38.
- Figure 9 is in very bad quality. Author should create own drawing of this very simple figure.
- Bogie can consist also of one axle.
- Bogie Y 32 is not modified production of Y 25 bogie!!!
- Description of bogie of locomotive class 744 is abstruse and locomotive class 744 is product of CZ-LOKO.

Despite mention above facts I can say that author has fulfilled the master thesis assignment although he has not used the theoretical analysis in complete form. Author's approach to solution of the thesis was active, he was coming regularly to consultations with supervisor and he worked independently enough. During consultations I felt little author's disadvantage caused insufficient basic knowledge about railway vehicles as well as mechanical engineering which appropriates to any student who graduates bachelor degree of this study branch. The using of publications should be in better level – I expected detailed explanation of chosen chapters from publication concerned just to mechanical springs by A. M. Wahl. with some application. The technical level of this thesis is good but for any useful benefit to the branch of flexicoil spring, more detailed analysis of the computational model is necessary. I recommend this thesis for defence and I rate it by mark

Good

I require answering the following questions:

- Is there any difference for using equations (2) and (3)?
- Is there any reason for using such high value of friction coefficient in FEM model?
- Could you explain the term „lateral stress" and its evaluation (p. 41)?
- Is there any reason for increasing of shear stress in last calculation step in fig. 37c?
- What do you mean by formulation about change of vertical and lateral deformation of spring during life time?
- How can you explain the fact, that lateral stiffness of experimental results is almost two times higher than calculation results, but measured stress is for all cases lower than stress calculated with help of FEM model?

In Česká Třebová, 2nd June 2014

Ing. Aleš HÁBA, Ph.D.