Review of Dissertation Thesis

Strength of glue joints of metallic materials in connection with design of joints

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Description

The thesis, elaborated in accordance with Study and Exam Regulations of the University of Pardubice, deals with the problems of strength of glued joints of metallic parts. It has 98 pages including symbols, figures and references, and is divided into seven chapters.

The first chapter introduces briefly the topic. Chapter 2 gives a thorough literature review (adhesively bonded joints, their advantages and limitations, kinds of modern adhesives and characteristic stresses caused by various kinds of loading). Chapter 3 explains the motivation for the work and tells what will be studied in theoretical way, by computer modelling and by experiments. Chapter 4 presents the theoretical base for the analysis of the processes in the cohesive zone of glued joints and introduces parameters suitable for their characterisation, such as stresses in the cohesive zone, stiffness of the joint, fracture energy and separation strength. Ing. Kocabaş uses these quantities in normalised (dimensionless) form, which is more general. In the dissertation, emphasis is put on computer modelling using the finite element (FE) method. Material models of the investigated adhesives and adherends are given also in Chapter 4, as well as the details of the FE models used in the thesis.

Chapter 5 describes the tests for obtaining the characteristics of the used materials (stress-strain diagrams, double cantilever beam (DCB) and end-notched flexure (ENF) tests) and tests for obtaining the strength of adhesive joints. It appears that the strengths, measured on real specimens, using two adhesives, three thicknesses of adherend and three lengths of overlap, are reasonably close to the values obtained by numerical simulation. Therefore, most of the following investigation was based on computer modelling.

Chapter 6 presents the results of simulation: distribution of peeling and shear stresses and load carrying capacity (failure loads) for the arrangements of the joints mentioned above. Also detailed stress distributions, obtained by FE modelling, are shown.

Chapter 7 summarizes the works done and the achieved results.

The dissertation thesis ends with the list of references (55), glossary of terms, and the list of author´s publications (5 papers in the journals or proceedings of international conferences); Ing. Kocabaş is the first author in two of them.

General evaluation

a) The technology of bonding by gluing is promising and replaces other joining technologies especially in the manufacturing of transport means (cars, rail vehicles, and aircrafts). The dissertation, which helps in understanding and design of such joints, is thus topical.

b) The text of the thesis is understandable and the individual chapters are arranged in a logical way. The experiments were described carefully.

c) The dissertation work has fulfilled the objectives formulated in Chapter 3.

d) There are several positive outcomes of the thesis, summarised as follows:

- Ing. Kocabaş has prepared a computer program (in ABAQUS) for the analysis of glued joints, whose results agree well with the values measured on real specimens (compare e.g. Figs. 5.14 and 5.15 with Figs. 5.16 and 5.17).

- The work has proven the suitability of the cohesive zone model for the study of glued joints.

- The finding that the load carrying capacity of joints approaches to some "asymptotic" value for certain ratio $\sigma_Y t$ and does not increase any more (see, e.g., Figs. 6.12 - 6.14) is very important for the design of glued joints. The thesis also presents advice for optimised design.

- The approximation of stress-strain curves by hyperbolic function *tanh* is simple and elegant.

e) The thesis does bring new information and can help in the improvement of glued joints, especially in vehicle technology.

f) The extent and quality of the submitted thesis (98 pages including figures, tables and references, plus the list of figures and abbreviations) and the five published works of the applicant (related to the dissertation) are adequate.

g) The dissertation thesis meets the general requirements for awarding the title Ph.D.

Therefore, **I recommend that this dissertation thesis is defended** and - in positive case - that the applicant is awarded the title Ph.D. (Several questions and critical remarks, written below, should be answered during the discussion).

24th October 2016

Prof. Ing. Jaroslav Menčík, CSc.
reviewer

Questions

- How was the instant of failure onset determined in computer models?

- How many tests were done for obtaining mechanical properties? Were the properties of steel (Table 5.1 on p. 47) obtained by measurement or from a data-sheet? Do you have an idea about their variance?

Critical notes

- The text was prepared carefully, without printing errors. Only the "clever word-processor" replaced the correct word "kind" by "king" on p. 28 and "indented" by "intended" on p. 29.

- The explanation of assigning colours to stresses (Figs. 6.22, 6.24, 6.26 and 6.28) is missing.

- Explanation of several quantities is not given in the List of symbols, but rather hidden in the text. Moreover, K_{nn}[N/mm^3] is denoted as stiffness in the List, but as elastic modulus in Equation (4.1) on p. 31. Specific fracture energy Γ_n is denoted as fracture toughness on p. 44, but the term fracture toughness is generally used for critical value of stress intensity factor K_{IC}. Such mistakes are of rather formal character, but make the text less readable. *end*