EFFECT OF LOADING RATE ON FRACTURE TOUGHNESS MEASUREMENT OF 7010 ALUMINIUM ALLOY AND MILD STEEL

By

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Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, In Fulfilment of the Requirements for the Degree of Master of Science

June 2004

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Professor ShahNor Basri, Ph.D.

Faculty: Faculty of Engineering

The fracture toughness of structural material is a matter of vital interest in residual life and safety assessment work. Many structures in service today were erected in a time when safety requirements in terms of notch or fracture toughness were not specified. This means that often very little is known about the defect tolerance of such structures under various loading conditions. The effect of intermediate loading rates upon fracture toughness of structural material has not been widely reported compared with static or very high loading rates. In the present work, the effect of intermediate loading rates upon fracture toughness and yield strength properties of aluminium alloy 7010-T7651 and mild steel has been investigated. The experimental study has been done on compact tension specimen and tensile specimen of both materials at different cross-head speeds. The effect of increased cross-head speed is found to increase yield strength properties and to reduce the fracture toughness values of aluminium alloy and mild steel. Numerical modelling using finite element software LUSAS has been done and well predicted the load versus crack mouth opening displacement of the specimen imposed

with load. The results show that Stress Intensity Factor, J-integral and Crack Tip Opening Displacement at certain values of load applied can be found from the energy method.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

KESAN KADAR BEBANAN KE ATAS PENGUKURAN NILAI KEKUATAN KEPECAHAN ALOI ALUMINIUM 7010 DAN KELULI LEMBUT

Oleh

JAMILAH BINTI TALIB

Jun 2004

Pengerusi: Profesor ShahNor Basri, Ph.D.

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Kekuatan kepecahan struktur bahan adalah perkara menarik di dalam kerja hayat tinggalan bahan dan juga kerja penilaian keselamatan bahan. Banyak struktur di dalam perkhidmatan yang mengalami kegagalan mengikut masa apabila keperluan keselamatan pada segi kekuatan kepecahan tidak dimaklumi. Ini bermakna selalunya terlalu sedikit diketahui tentang baki kecacatan sesuatu struktur di bawah pembebanan pelbagai. Kesan kadar bebanan pertengahan terhadap kekuatan kepecahanan struktur bahan tidak banyak dilaporkan berbanding dengan kadar bebanan statik dan kadar bebanan tinggi. Di dalam kerja yang dilaksanakan ini kesan kadar bebanan pertengahan terhadap kekuatan kepecahan dan kekuatan alahan aloi aluminium dan keluli lembut telah dikaji. Kajian ujikaji telah dilakukan terhadap spesimen tegangan mampatan dan spesimen tegangan kedua-dua bahan pada kelajuan berbeza. Kesan penambahan halaju didapati menambahkan nilai kekuatan alahan dan mengurangkan nilai kekuatan kepecahan aloi aluminium dan keluli lembut. Kajian permodelan berangka menggunakan perisian unsur terhingga LUSAS telah dijalankan dan telah dapat meramalkan graf beban melawan anjakan bukaan bahan yang dikenakan beban.

Keputusan menunjukkan Faktor Keamatan Tegasan, J-integral dan Anjakan Bukaan Hujung Kepecahan pada sesuatu nilai kenaaan beban dapat dicari menggunakan kaedah tenaga.

ACKNOWLEDGEMENTS

The author would like to express her gratitude to all who have helped in the production of this work. She is particularly indebted to Prof. Ir. Dr. ShahNor Basri, Assoc. Prof. Dr. Waqar Asrar, Assoc. Prof. Dr.Prithvi Raj Arora and Assoc. Prof. Ir. Dr. Mohamad Nor Berhan for their guidance, encourage and valuable suggestion.

Particular mention is due to the Faculty of Mechanical Engineering, Universiti Teknologi Mara for the permission to use the machine. The author gratefully acknowledges the assistance of the Technical Staff of the Department of Aerospace Engineering, Universiti Putra Malaysia.

Finally the author wishes to thank Universiti Teknologi Mara for the financial support.

I certify that an Examination Committee met on 22nd Jun 2004 to conduct the final examination of Jamilah Binti Talib on her Master of Science thesis entitled "Effect of Loading Rate on Fracture Toughness Measurement of 7010 Aluminium Alloy and Mild Steel" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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