UNIVERSITI TEKNOLOGI MARA

EFFECT OF POLYURETHANE INSOLE ON STANDING USING FOOT PRESSURE MEASUREMENT AND FINITE ELEMENT ANALYSIS

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Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science

Faculty of Mechanical Engineering

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Standing for long hours can contribute to foot discomfort and may cause foot disorder. When a person is performing activities in prolonged standing while wearing an ineffective material of shoe insole he may experienced foot pain and sometime may cause injuries. The foot pain is potentially a result of increased in plantar pressure under the foot. Many researchers have been reported to provide solutions that reduce this foot pain. However, most of the researchers are focused on clinical testing only. The research design and methods undertaken here will be technical testing rather than clinical through quantitative measurement. The purpose of this research is to produce a suitable insole that can provide a layer of lining between the foot and the shoe. The objective of this lining is to reduce plantar pressure. Three different densities of Polyurethane (PU) have been utilized for the case studies; soft insole, medium hard insole and hard insole. PU was selected as the insole material based on the capacity and availability of manufacturing the insoles locally and the variation of its physical properties were achieved by manipulating and varying the process parameters using the Polyurethane injection foam insole process. Apart from being able to attain the design of the shoe insoles specially adopted for Malaysians, the proposed solutions are also custom made in terms of the construction aspects for the length and width of the shoe insole based on both the foot mold and specific foot condition. The pressure distribution of the foot was evaluated by using the F-Scan® in-shoe pressure measuring system to study the pattern of plantar (bottom or surface of the foot) pressure distribution before and after different intervention. It can be concluded that the in-shoe foot pressure measurements are significantly lower than the ones measured without the use of insoles under normal standing condition. Hard PU insole contributes about 19% higher pressure than a soft flat insole while medium hard insole contributes 12% higher pressure compare to soft insole(p=0.001;p<0.005; n=20) . This pattern of results shows that soft PU insole has a role in reduction of peak plantar pressure and provides more relieve to subjects and assist in providing comfort while standing. Numerical analysis assessment is used to validate the established insole effectiveness. The numerical analysis assessment of the PU insole under specific loading and force conditions using a foot model generated from a CT-Scan showed that the plantar pressure on the heel from the FEA has a variance of 23% from the experimental results for barefoot condition and 26% when using PU material as the insole material. Comparing from both the experiments and the simulation it can be conclude that by providing a suitable insole as a lining between the foot and the shoe it can reduce the peak plantar pressure thus reduce the foot discomfort. It can be concluded that, regarding footwear material, the insoles made from soft material must always thought as important especially footwear designed for people with foot disorder.

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