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EVALUATION OF PLASTIC SEATS IN HANDICAPED MOBILITY DEVICES

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ABSTRACT

A combined finite element analysis (FEA), material forensic analysis and an experimental technique are presented for the purpose of assessment of damage characteristics and occupant safety performance levels of molded plastic seating systems typically used in low speed "power mobility wheelchair devices" designated for handicapped individuals. Current applicable safety test criteria of the ISO 7176-8 and WC-08 of ANSI/RESNA provide some experimental measures regarding static and dynamic performance for wheelchair devices, but these tests do not explicitly include assessment of seat rearward load resistance and occupant safety while reaching for objects located to the rear of the device. In an actual incident, the handicapped user of an ISO certified "power wheelchair device" leaned rear against the seatback and fell rearward when the molded plastic seat base fractured, resulting in a fatal injury. An exemplar electric scooter wheelchair device was tested to the ISO 7176-8 criteria at an independent laboratory and it failed in the same manner as the accident wheelchair seat. Microscopic evaluations of both failed plastic seats indicated that the seat material was contaminated by the use of recycled plastics mixed with the intended plastics. The results of the FEA indicated that high stress regions were found in the same locations as the fracture failures of the incident seat and the exemplar. In addition, quasi-static verification seat strength tests were run on a second exemplar plastic seat and these tests confirmed the FEA, but also indicated additional fractures and failure modes in the seat design. The FEA was then used to redesign the seat structure such that the high stress regions were reduced with minimal shape changes. Details of the methodology and recommendations are provided and should be of use for early design safety improvements.

Background – handicap mobility device performance

Standards applicable to "powered wheelchairs" and "electric scooter devices" intended for everyday use by physically handicapped individuals are limited in scope and do not adequately address "injury risks and design reliability" issues associated with certain common everyday tasks such as "leaning rearward" in the seat of such devices so as to retrieve a package located behind. In most cases the seat systems of such devices are made of easily molded plastic materials. In addition, these devices are often advertised as being able to support handicapped individuals who may weigh over 125 kg. The primary standards are the ISO 7176-8 [1] and WC-08 of the ANSI Rehabilitation Engineering and Assistive Technology Society of North America (ANSI/RESNA) [2]. These standards provide some experimental measures regarding component strength and dynamic fatigue performance but do not address the above seat rearward load issue.

Certification to the ISO and ANSI/RESNA standard is generally performed prior to introduction of the device into the stream of commerce. After initial certification there is no requirement for periodic recertifications. Consequently, after a period of use and time on the market, "injury risk" problems may arise from "design flaws", such as failure to address potential "stress

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