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## Abstract

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According to the International Standards Organization 2631-1 standard on human vibration, individuals in a seated position are at risk of injury due to whole-body vibrations when exposed for long periods of time. Wheelchair users fit this description perfectly; however, little research has been conducted to evaluate the amount of vibration transmitted to a wheelchair user. The vibration exposure produced by traversing nine surfaces was evaluated by having 10 individuals without disabilities propel over them in both a manual wheelchair at 1 m/s and a powered wheelchair at 1 and 2 m/s. Root-mean squared (RMS) vertical vibration was examined to determine if differences existed between surfaces. At 1 m/s for both the manual and the powered wheelchair the 8-mm bevel interlocking concrete surface produced significantly higher RMS vertical vibration than the other surfaces. At 2 m/s in the powered wheelchair, the poured concrete surface (control) produced the significantly highest RMS vertical vibration. Based on the manual and power wheelchair results of this study, use of selected ICPI pavers would be acceptable for any route traveled by individuals using wheelchair. Furthermore, a 90 degrees herringbone pattern is preferred over the 45 degrees pattern, and it is recommended that for safety reasons regarding vibration exposure a bevel of less than 6 mm should be used.

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## Abstract

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**BACKGROUND:** Obstacles such as bumps, curb descents, and uneven driving surfaces cause vibrations that affect the wheelchair, and in turn, the wheelchair user. Chronic exposure can cause low-back pain, disk degeneration, and other harmful effects. Little research has been conducted to assess the vibrations experienced by wheelchair users. **OBJECTIVE:** The purpose of this study was to conduct an evaluation of the vibration exposure during electric-powered wheelchair driving and mechanical energy requirements for manual wheelchair propulsion over selected sidewalk surfaces. The goal was to determine the criteria for a wheelchair-pedestrian access route that does not require excessive propulsive work or expose wheelchair users to potentially harmful vibrations. **METHODS:** Ten unimpaired individuals participated in this study. Six sidewalk surfaces were tested. Measured variables included power of the acceleration per octave, mechanical work to propel over surfaces, peak acceleration, and frequency at which peak acceleration occurs. **RESULTS:** For both the manual and electric-powered wheelchair, at 1 m/s, significant differences were found in peak accelerations between the seat and footrest ( $P < 0.0001$ ) and between the

sidewalk surfaces ( $P = 0.004$ ). The greatest risk for injury caused by shock and vibration exposure occurs at frequencies near the natural frequency of seated humans (4-15 Hz). The values for work required to propel over the surfaces tested were not statistically significantly different. Besides appearance and construction, the only distinguishing characteristic was surface roughness caused by the joints. **CONCLUSION:** When treating the poured concrete sidewalk as the standard, surfaces 2, 3, 5, and 6 compared most favorably in terms of vibration exposure, whereas surface 4 produced mixed results. Surfaces 2, 3, 5, and 6 yielded results that were similar to the poured concrete sidewalk and could be considered acceptable for wheelchair users. In conclusion, surfaces other than the traditional poured concrete can be used for pedestrian access routes without adding vibration exposure or reducing propulsion efficiency.