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Humans' Physical Strength Capacities on Different Handwheel Diameters and Angles

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Abstract : Handwheels are common to numerous industries, such as power generation plants, oil refineries, and chemical processing plants. The forces required to manually turn handwheels have been shown to exceed operators' physical strengths, posing risks for injuries. Therefore, the objectives of this research were twofold: (1) to determine humans' physical strengths on handwheels of different sizes and angles and (2) to subsequently propose recommended torque limits (RTLs) that accommodate the strengths of even the weaker segment of the population. Thirty male and thirty female participants were recruited from a university student population. Participants were asked to exert their maximum possible forces in a counter-clockwise direction on handwheels of different sizes (35 cm, 45 cm, 60 cm, and 70 cm) and angles (0°-horizontal, 45°-slanted, and 90°-vertical). The participant's posture was controlled by adjusting the handwheel to be at the elbow level of each participant, requiring the participant to stand erect, and restricting the hand placements to be in the 10-11 o'clock position for the left hand and the 4-5 o'clock position for the right hand. A torque transducer (Futek TDF600) was used to measure the maximum torques generated by the human. Three repetitions were performed for each handwheel condition, and the average was computed. Results showed that, at all handwheel angles, as the handwheel diameter increased, the maximum torques generated also increased, while the underlying forces decreased. In controlling the handwheel diameter, the 0° handwheel was associated with the largest torques and forces, and the 45° handwheel was associated with the lowest torques and forces. Hence, a larger handwheel diameter –as large as 70 cm– in a 0° angle is favored for increasing the torque production capacities of users. Also, it was recognized that, regardless of the handwheel diameter size and angle, the torque demands in the field are much greater than humans' torque production capabilities. As such, this research proposed RTLs for the different handwheel conditions by using the 25th percentile values of the females' torque strengths. The proposed recommendations may serve future standard developers in defining torque limits that accommodate humans' strengths.

Keywords : handwheel angle, handwheel diameter, humans' torque production strengths, recommended torque limits
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