

Biomechanics of securing vehicles for transport

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Abstract

Vehicles are transported from the assembly plant to the dealer using multi-vehicle tractor-trailer systems, and are secured by the drivers using chains or straps that are tightened by ratchet mechanisms. To our knowledge, no detailed biomechanical study has previously been conducted on the procedure of securing the vehicles to the transport system, a manual handling activity. This study presents the results of research conducted to study the biomechanics of this activity on a tractor-trailer system utilizing metal chains to secure the vehicles. Three different body positions were analyzed, which encompass the majority of the different ratchet configurations. To perform the analysis, a six-camera motion capture system was used to capture the body positions throughout the process. A standard ratchet bar was instrumented with a strain gauge to record the force exerted, and these data were captured and synchronized with the motion via the motion capture system. The body postures and external hand forces associated with the securing process were then input into the 3-D Static Strength Predictor Software program, and the individual joint strength requirements and low back compression forces analyzed. The external hand loads necessary to secure the vehicles to the transport system ranged from 165 to 485 N. The combination of postures and external hand forces required at the peak force were determined to be achievable by 75% or more of the female workforce population, and the low back compression forces did not exceed the NIOSH Back Compression Design Limit value of 3400 N.

Background

The transporting of automobiles from the factory to the dealer typically involves the use of a multi-vehicle tractor-trailer system. The vehicles are loaded by the truck driver onto the tractor-trailer individually, and must then be secured prior to transport. There are two types of systems used for securing the vehicles, one involving a system of chain, hook, and ratchet mechanisms that are secured to the vehicle undercarriage, and the second involving straps that mount over the wheels. Securing the vehicles using either system includes the use of a hand-held bar to tighten either the chains or straps, in either a pull or a pull that transitions to a push. This process therefore has much in common with other types of manual material handling processes found throughout industry. The force required to tighten and secure the vehicles varies throughout the tightening process, as does the specific

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