FORENSIC INVESTIGATION OF LUMBAR DISC INJURY IN AN INDUSTRIAL SETTING

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INTRODUCTION

A male warehouse employee was driving a three-wheel sweeper when he drove over a chip in the concrete floor subjecting him to a sudden vertical acceleration. The employee alleged to have sustained an acute lumbar intervertebral disc prolapse. A forensic biomechanical analysis was conducted to recreate the incident. Accelerations were measured using a representative human subject who drove the sweeper over the chip in the warehouse floor. Data were then compared to known lumbar disc tolerance levels.

METHODS

A male volunteer was used who was of representative weight of the sweeper driver. The subject and sweeper chassis accelerations were measured by two triaxial accelerometer packs. Human subject accelerations were measured at the lumbar level. Travel path over the chip in the floor was determined by warehouse employee interviews. Multiple runs were made with all three wheels interacting with the chip independently. Figure 1 demonstrates the test setup.

Figure 1: Test setup

Figure 2 depicts a plan view of the chip in the concrete floor. Tests were video taped from two angles for overall kinematic analysis. Tire-to-chip interaction was confirmed using video footage. Data were sampled at 10000 Hz and filtered using a low-pass digital Butterworth filter with a cut-off frequency of 60 Hz.

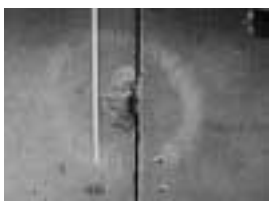

Figure 2: Chip in floor

RESULTS AND DISCUSSION

Figure 3 demonstrates a cross plot of vertical accelerations of the subject and sweeper for all tire-to-chip interaction tests.

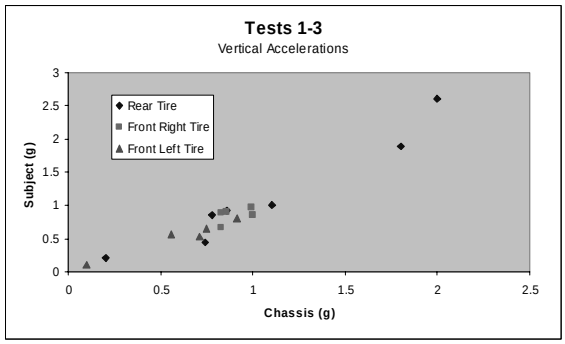

Figure 3: Vertical accelerations for all tire-to-chip interaction tests

The rear tire interaction tests produced the highest vertical acceleration response for both sweeper and subject. Lumbar compressive load was calculated for all lumbar levels using the formula

$$F = ma$$

where (m) represents the mass supported by the respective lumbar level (Duval-Beaupere et al, 1990). The maximum calculated load for all tire-to-chip interaction tests was 907 N at the L5 level. Video analysis demonstrated negligible lumbar flexion. Lumbar disc prolapse has been experimentally produced by the application of a compressive load in conjunction with hyperflexion and lateral bending (Adams and Hutton, 1982). The average compressive load reported to produce disc prolapse was 5448 N (± 2366). It was determined that the lumbar loading calculated in this study was not sufficient to produce disc prolapse. This is supported by the lack of injury to the human subject tested.

SUMMARY

This study investigated the claim of an acute lumbar disc prolapse as a result of driving a sweeper over a chipped concrete floor. Acceleration data were collected from a human volunteer. Compressive lumbar loads experienced during the event were calculated. Compressive lumbar loads were then compared with loads reported to cause disc prolapse in a laboratory study. The calculated loads were found to be well below known tolerance levels. It was therefore determined that driving the sweeper over the chip in the concrete floor was not the probable cause of an acute lumbar disc prolapse alleged by the sweeper driver.

REFERENCES

Adams, M.A., Hutton, W.C. (1982). *Spine* 7(3), 184-191.
Duval-Beaupere, G. et al (1990). *SAE Technical Paper Series*, 902306, 13-21.