

**Potential Problem with Acetabulum
Load Cell in SID-II's Dummy**

Gregory J. Dakin
Marvin T. Hatchett
Raul A. Arbelaez

September 2001

**INSURANCE INSTITUTE
FOR HIGHWAY SAFETY**

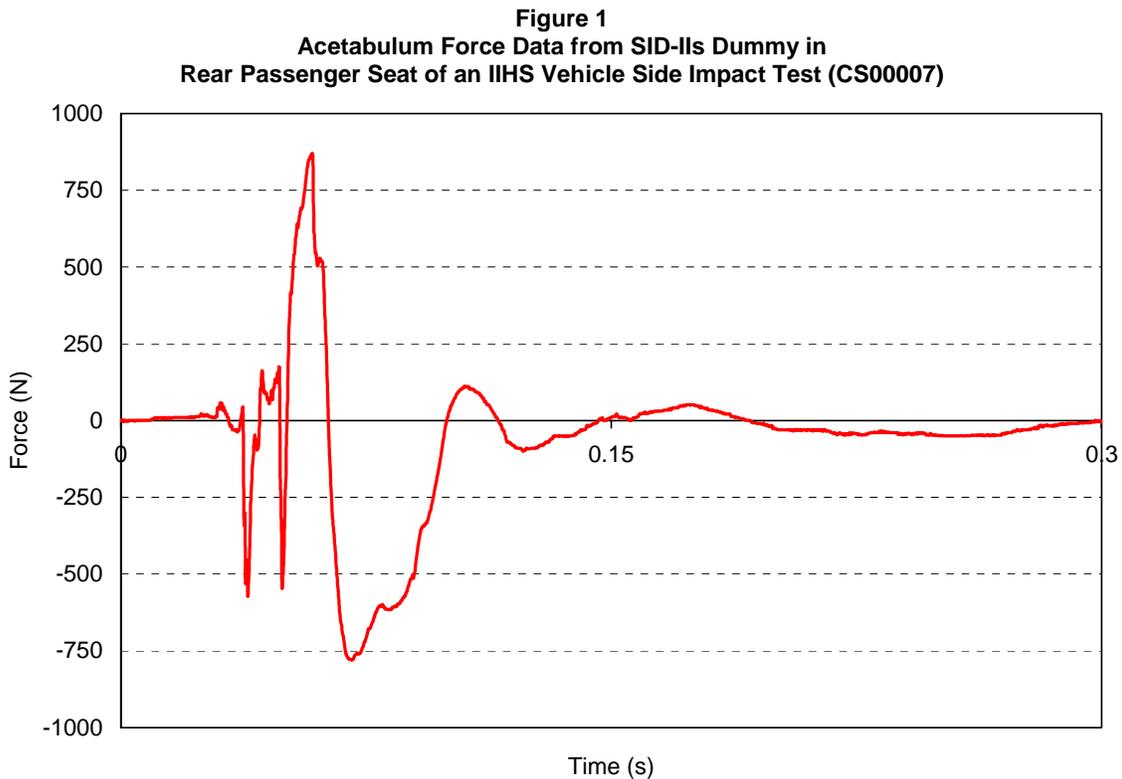
1005 NORTH GLEBE ROAD ARLINGTON, VA 22201

PHONE 703/247-1500 FAX 703/247-1678

www.iihs.org

Problem

Based on review of the pelvic data from a series of side impact tests conducted by the Insurance Institute for Highway Safety and Transport Canada, there appears to be a problem with the acetabulum load cell configuration in the SID-II's dummy. Many of the acetabular loading curves were observed to go negative (Figure 1), which would be indicative of tensile loading in the area of the greater trochanter. This trend was observed for dummies positioned in driver and rear passenger seats. Similar negative acetabular loading values were reported in the prove-out testing of the SID-II's alpha prototype (Kirkish et al., 1996); however, the investigators did not provide a biomechanical explanation for such loads.



Data from this test, as well as others, can be found online (www.highwaysafety.org/presentations/sice.htm).

Possible Source of Problem

Because there was no kinematic explanation for tensile loading on the impact side of the pelvis, a SID-II's dummy was disassembled for further investigation. When the femur on the impact side was flexed 90 degrees and then internally rotated (Figure 2a), the inferior edge of the femur assembly could swing laterally and upward until it made contact with the metal back of the acetabulum load cell (Figure 2b). Because the loading region (black portion) of the load cell is rigidly attached to pelvic assembly, a lateral load to the metal back (silver portion) of the cell actually causes a negative force. Forces up to -1000 N were fairly easy to achieve in the laboratory by using the tibia as a lever to rotate the femur about its longitudinal axis. It is unknown if the acetabulum load cells are calibrated to report negative forces accurately.

Figure 2a
Femur on Impact Side Flexed
90 Degrees and Internally Rotated

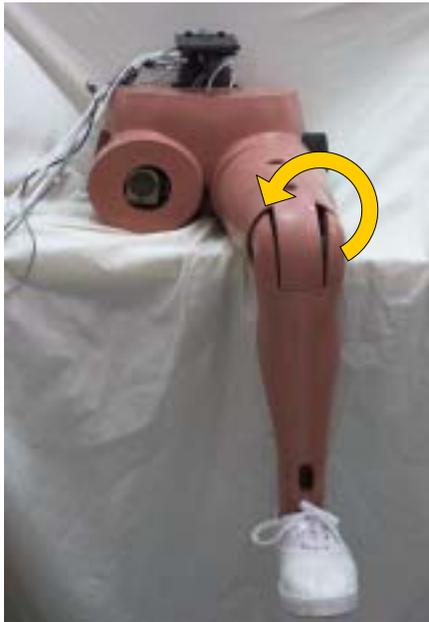
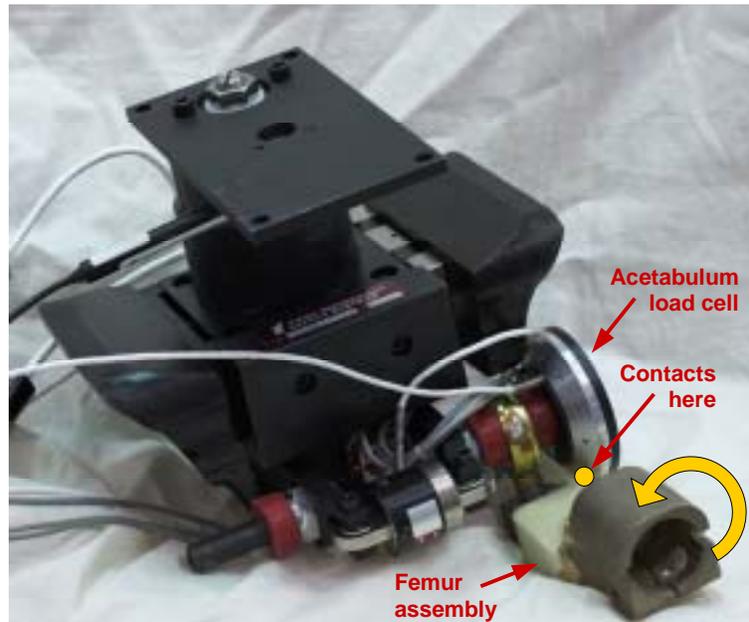


Figure 2b
Inferior Edge of Flexed Femur Assembly can Press
Against the Metal Back of Acetabulum Load Cell



Review of the onboard crash test film indicated that internal rotation of the femur may have occurred when the intruding door collapsed inward and downward, trapping either the foot or the femur itself. The force of the impact pushed the pelvic region of the dummy inboard, thus causing the flexed femur to internally rotate as the dummy translated toward the center of the vehicle.

Depending on the timing of the impact force on the acetabulum and the internal rotation of the femur, the peak acetabular loading force could be underreported by 1000+ N. A mathematical correction of the data seems implausible at this point because there is no way of knowing exactly when, and to what extent, the femur assembly is pressing on the back of the acetabulum load cell. A mechanical intervention is needed to prevent contact of the femur assembly with the acetabulum load cell, such as redesigning the femur assembly itself or moving the load cell laterally until contact is not possible.

References

Kirkish, S.L. et al. 1996. Status of prove-out testing of the SID-II α prototype (96-S10-O-15). *Proceedings of the 15th International Technical Conference on the Enhanced Safety of Vehicles*, 1690-1716, Washington, DC: National Highway Traffic Safety Administration.