COMPARATIVE ANALYSIS OF SIX CRASH DUMMY ACCELERATIONS, 12, 20 and 32g, ON CBM SEATS VS. SIMILAR TESTS PERFORMED WITH STANDARD SEATS.

Result data provided by HYGE Sled tests.

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Summary.

The Counter Balanced Motion (CBM) Seat design works dynamically in conjunction with body mechanics. More specifically, the center of rotation of the seat is centered proximate (0.1m) to the seated body's center of mass. The CBM Seat dynamically moves to restrain the lower body and:

1) Improves the defensive posture of the body before the peak of the crash pulse.
2) Absorbs sizably more deceleration forces on the lower body to reduce leg and pelvic injury.
3) Reduces head trajectory, head, and neck injury loads.
4) Improves the efficiency of restraint systems below critical operating limits by an optimally proportional load bearing contribution between the CBM Seat, belt harness and airbag systems.

Earlier Madymo crash simulations of the CBM Seat calculated a 33 to 70% reduction in injury loads to the chest and legs. In addition, it calculated a reduction in Head Injury Criteria (HIC) values of 13-30% over the standard equipment

This paper describes actual sled test results with the CBM Seats optimized for the mid-size automobile and compares it to the same mid-size automobile tests with standard equipment seats. The sled tested CBM Seats show a net reduction in leg loads of 36-60% and 26% reduction in head and neck loads.

During 12, 20 and 32g tests the CBM mechanism performed with 100% reliability. First, it released the seat tilt lock at 28 to 21 ms respectively. Second, the seat motion pulsed in accord with the automobile pulse peak 75 to 55ms, increasing the seat containment angle and effectively restraining the pelvis during peak forces. Injury loads registered by the instrumentation show a sizable difference between standard equipment cases and CBM Seat motion cases. The CBM Seat significantly reduced head, neck, and leg injury loads in all frontal crash simulations tested.

Figure 4 at a 12g crash pulse with the CBM seat shows the posture of the dummy at 150ms maximum forward head trajectory with 115º knee angle and 20º neck angle. The seat is in rear bound trajectory and returns to 0º.

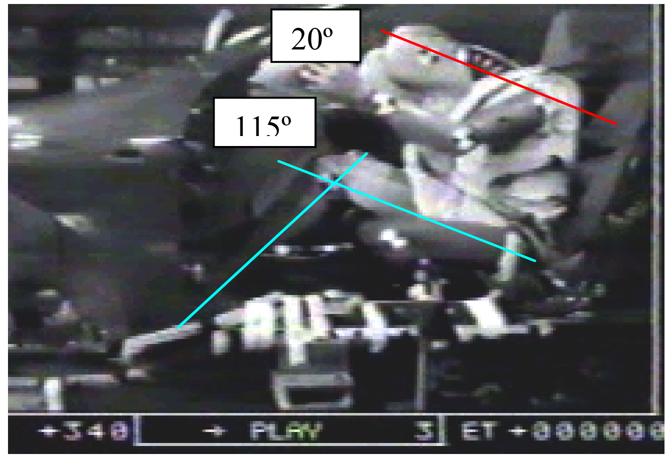

Figure 4: Maximum head trajectory (4094) (CBM Seat).

Figure 6 at a 12g crash pulse with the standard seat shows that the dummy's legs are considerably more extended and the head is 10º further than with the CBM Seat at 150ms, the maximum forward head trajectory.

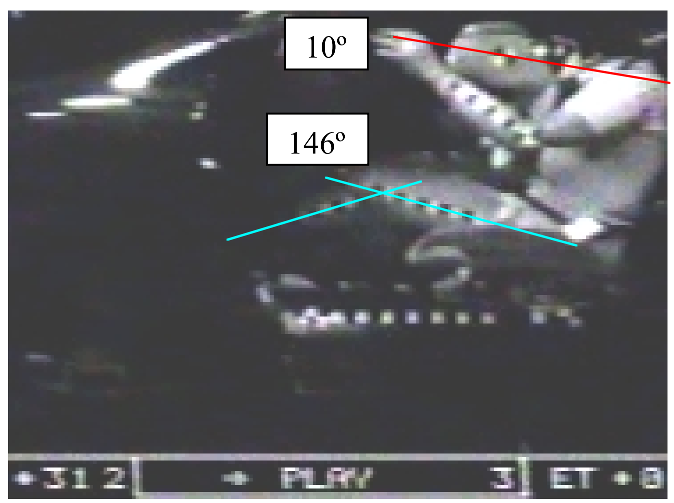

Figure 6: Maximum head trajectory (3826) (Standard Seat).

Figure 6 shows that with a 146º knee angle, the lower leg is well extended impacting into the floor.

The dummy's instruments show the results of the CBM intervention on the femur forces. The CBM mechanism sizably changes the dynamics that extends the legs to impact the toe pan floor. Thus the CBM Seat maintains lower femur forces.

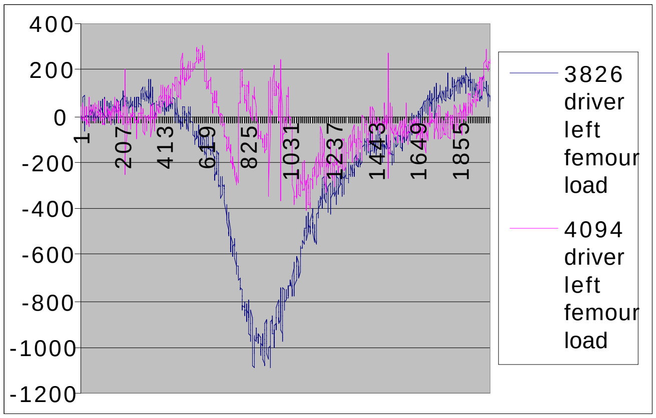

Figure 7: Comparison of femur forces.

The above force diagram for test #4094 shows loads oscillating between + 0.3 and – 0.4kN compared to +0.2 and –1kN for test #3826, showing reduced femur loads by 60%, from –1kN to - 0.4kN. This indicates that the CBM Seat eliminates the dynamics that extend the legs to impact the floor with high forces. It does this specifically by folding the legs at the knees and more effectively restraining the pelvis.

At a 20g crash pulse Figure 15 shows the beginning of the rebound at 100ms. The CBM maintains containment angle, 31ms, during the entire forward momentum period.

Figure 15: Momentum direction reverse (4095).

This clearly shows how the body is moved into a safer posture during impact. At 115ms, the maximum forward head trajectory into the airbag is observed. At the same time, a -4º rotation of the seat and lower body passing through 8º in rear bound trajectory is in progress.

Consistent in all CBM tests, in test #4095 the CBM mechanism sizably changes the dynamics that extends the legs practically eliminating impact to the toe pan floor.

Conclusion

The ideal restraining system can take advantage of the fact that the CBM Seat eliminates the mechanism that creates high forces in the legs specifically by folding the legs at the knees. Also, that the CBM Seat reduces head trajectory thus safely accommodating a more effective 50-liter airbag. And that pretensioners or a 14% elongation belt harness in conjunction with the CBM Seat further reduce head and torso loads.

This ideal restraining system including the CBM Seat will provide a net reduction in leg loads in the range of 36-60%, a 26% reduction in neck forces and a reduction of HIC values of 13-30% over the present standard restraint systems.

The addition of the CBM Seat to the restraint systems package of seatbelt and airbags significantly increase safety to occupants in a frontal collision.

Reference

1. Serber, H., "Counter Balanced Motion (CBM)-Dynamic Seat," SAE, paper # 1999-01-0632.