Insurance Institute for Highway Safety
Crashworthiness Evaluation

Crash Test Report
2003 Lincoln Town Car (CEF0313)

Vehicle identification number: 1LNHM82W43Y697486
Body style: Large 4-door sedan
Engine/transmission: Longitudinal 4.6-liter V8, 4-speed automatic transmission, rear-wheel drive

Standard crashworthiness features:

Driver and right front passenger dual-stage front airbags with variable inflator output depending on crash severity, belt use, driver seat adjustment, and weight of right front passenger
Driver and right front passenger front airbags also have separate deployment thresholds for belted and unbelted occupants
Driver and right front passenger seat-mounted side airbags (designed to protect head and thorax)
Dual-locking shoulder belts (front outboard and all rear seating positions)
Shoulder belt height adjusters (front outboard seating positions only)
Seat belt crash tensioners (pyrotechnic, front outboard seating positions only)
Seat belt force-limiting mechanisms (front outboard seating positions only)
Rear center lap/shoulder belt
Right front and all rear shoulder belt retractors are convertible from emergency to automatic locking for ease of child restraint use
LATCH system (rigid lower anchorages and top tether attachments) for child restraints (rear outboard seating positions)

Other standard safety features:

Adjustable brake and accelerator pedals
4-wheel antilock brakes

Vehicle specifications (provided by manufacturer):

Wheelbase:	299 cm
Overall length:	547 cm
Overall width:	199 cm
Curb weight:	1,968 kg

Vehicle specifications (measured):

Front bumper to firewall:	149 cm
Curb weight:	1,992 kg
Test weight:	2,092 kg (52% front, 48% rear)
Overall width:	199 cm

Nominal test parameters:

40.0 mi/h (64.4 km/h), 40% overlap, deformable barrier face with slotted bumper

Crash test date:

June 27, 2003

Figure 1
Precrash and Postcrash Side Views — 2003 Lincoln Town Car

Summary

A 2003 Lincoln Town Car was crash tested on June 27, 2003 into a fixed deformable barrier at 39.9 mi/h (64.3 km/h) and a 40 percent overlap on the driver side. A Hybrid III 50th percentile male dummy was positioned in the driver seat with the lap/shoulder belt fastened.

Measures of intrusion taken after the crash indicated the lower instrument panel in front of the dummy moved rearward 5 cm. Resultant intrusion in the driver footwell measured 10 cm in the area where a footrest typically be located and 11-14 cm at other places on the toepan. All doors remained closed during the test. After the crash, the driver door required additional effort but no tools to open. The left rear, right front, and right rear doors opened with ease. Deformation of the floor under the driver seat caused the seat to tip outboard and pitch forward.

The driver dummy was restrained by a three-point lap/shoulder belt and an airbag. During the crash, the belt crash tensioner activated and retracted 11 cm of shoulder belt webbing. The force-limiting mechanism allowed 3 cm of webbing to spool off the retractor from the tensioner-retracted position. During the crash, the dummy's head loaded the airbag until it contacted the steering wheel through the airbag. After rebounding from the steering wheel, the head moved rearward, upward, and outward, brushing the roof rail and window frame ahead of the B-pillar. After the crash, the upper end of the steering column had moved upward 3 cm and rearward 3 cm.

The maximum resultant head accelerations were 53 g from the steering wheel contact and 15 g from the roof rail/window frame contact. The maximum left femur axial force was –7.5 kN and remained above –6.0 kN for 11 ms. The maximum left upper tibia A-P moment was 194 Nm, significantly contributing to the left upper tibia index of 0.97. The maximum left tibia axial force was –4.2 kN. The maximum left tibia-femur displacement was –13 mm.

Test Conditions

This test was conducted according to the procedures specified in the IIHS Offset Barrier Crash Test Protocol (Version IX). The Hybrid III dummy positioned in the driver seat was equipped with instrumented lower legs that included feet modified to include two accelerometers and to have a 45 degree dorsiflexion range with soft stops at all extremes of foot-ankle motion. All dummy seating parameters were set according to the procedures specified for Federal Motor Vehicle Safety Standard 208 compliance testing (49 *CFR* Part 571.208 § 11). The dummy's left foot was placed in the area where a footrest typically would be located.

Seat back, shoulder belt upper anchorage, steering column, and foot pedal adjustments were set according to the manufacturer's specifications for government crash testing. Other adjustments were set according to the procedure specified for Federal Motor Vehicle Safety Standard 208 compliance testing (49 *CFR* Part 571.208 § 7 and 8). After final positioning of the dummy, measurements from various parts of the dummy to a number of vehicle interior points were made. These measurements and the seat back, shoulder belt upper anchorage, steering column, and foot pedal adjustments are described in the Appendix, Dummy Clearance Measurements.

Vehicle acceleration measurements were made by a triaxial arrangement of accelerometers mounted on the vehicle's longitudinal centerline and 57 cm behind its center of gravity (200 cm behind the front axle). The vehicle speed recorded just prior to impact was 39.9 mi/h (64.3 km/h), and the actual overlap was 40 percent.

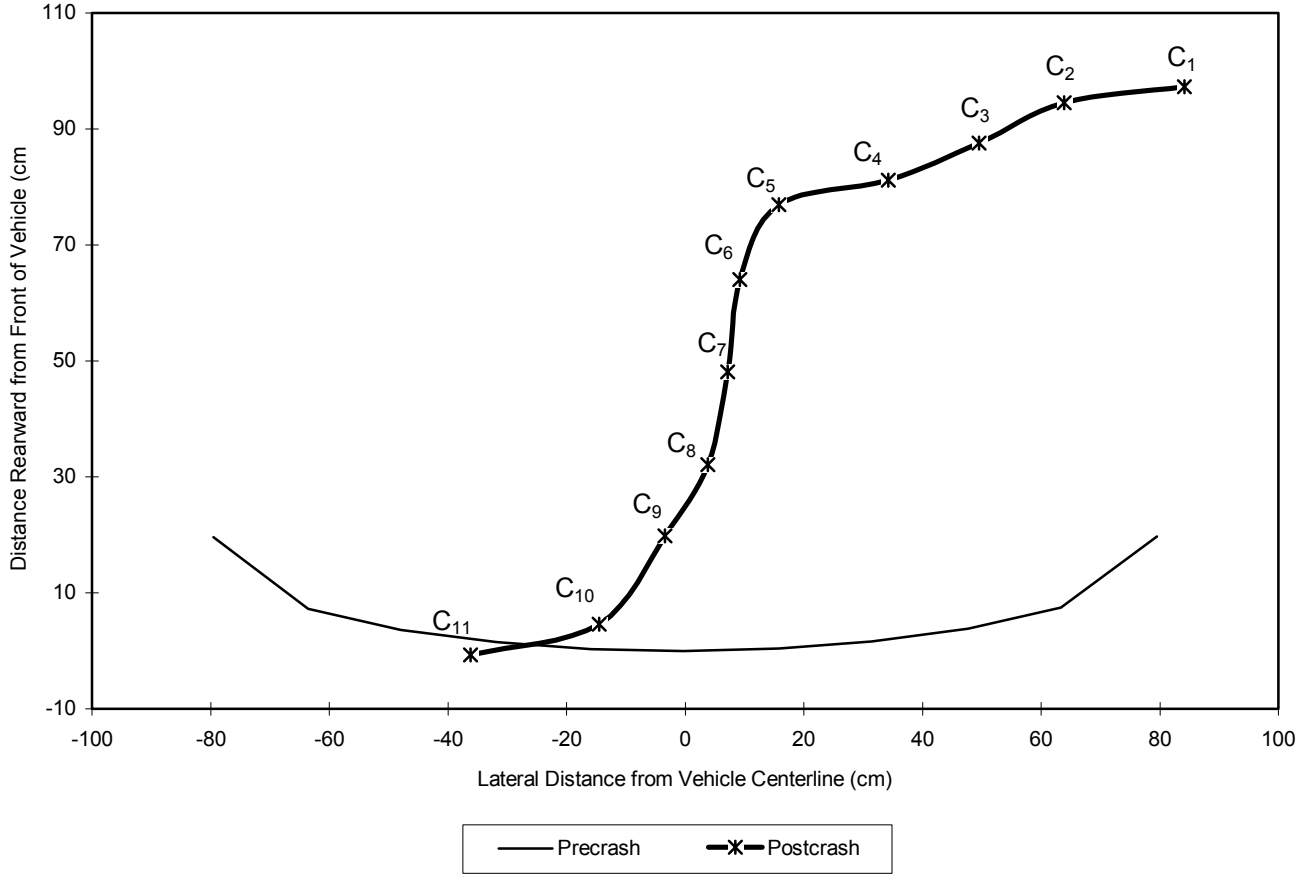
Structural Performance

All doors remained closed during the crash. After the crash, the driver door required additional effort but no tools to open. The left rear, right front, and right rear doors opened with ease. The driver door aperture shortened 7 cm, as measured at the lower edge of the window.

No fuel system leaks were observed after the crash.

Figure 2 illustrates the precrash and postcrash contour measures of the front bumper cover profile and the resulting permanent crush.

Figure 2
Front Bumper Cover Crush Contour — 2003 Lincoln Town Car



	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
Postcrash Contour (cm)	97	95	88	81	77	64	48	32	20	5	–1
Precrash Contour (cm)	20	7	4	2	0	0	0	2	4	7	20
Resulting Crush (cm)	77	88	84	79	77	64	48	30	16	–2	–21

The bumper cover was torn completely off the vehicle during the crash. The postcrash contour represents the best attempt to fit the cover back onto the vehicle. The length of the reference line was 159 cm precrash and 120 cm postcrash.

Various measures of intrusion were made after the crash. These residual measures of intrusion typically are less than the maximum deformation that occurs during the crash. The coordinate reference system for these measures is described in the IIHS Offset Barrier Crash Test Protocol (Version IX). The measures of deformation shown in Table 1 have been adjusted to better reflect the displacement of the various target locations relative to the driver, based on the locations of the four driver seat-attachment bolts. The average displacement of the seat-attachment bolts relative to the reference system also is shown in Table 1.

Table 1
Residual Measurements of Intrusion Relative to Driver Seat — 2003 Lincoln Town Car

Selected Locations*	Longitudinal	Lateral	Vertical	Resultant
Steering column (cm)	–3	–1	3	4
Left lower instrument panel (cm)	–5	–2	1	6
Right lower instrument panel (cm)	–5	–2	1	6
Brake pedal (cm)	–6	–1	–1	6
Left toepan (cm)	–12	–4	1	12
Center toepan (cm)	–14	–4	1	14
Right toepan (cm)	–11	–1	1	11
Footrest (cm)	–10	–3	1	10
Average displacement of the four seat-attachment bolts relative to reference system (cm)	–3	0	–5	n/a

* All measurements taken on driver side. From the driver's position, positive is forward, left, and up.

Restraint System Performance

Airbags

Driver: The uninflated driver airbag is approximately 56 cm in diameter, and the excursion of its center when inflated is limited by four tethers. The airbag is vented by two holes located at positions corresponding to 10 and 2 o'clock on the forward-facing surface of the airbag. Analysis of the high-speed film taken from camera position D indicated the airbag deployed at 34 ms into the crash and appeared to be fully inflated at 66 ms. The seat-mounted side airbag did not deploy during the crash.

Passenger: The mid-mounted passenger airbag did not deploy during the crash. A weight-based occupant sensor in the passenger seat controls deployment. The side airbag also did not deploy during the crash.

Seat Belts

The inboard lower anchorage points for the driver and right front passenger seat belts are attached to and move with the seats. The front outboard lower anchorage points are bolted to the sills at the base of the B-pillars. The center front position has only a lap belt. During the crash, 11 cm of the driver's seat belt webbing was pulled by the belt crash tensioner into the retractor through the D-ring, as measured by a pull-string mounted between the webbing and B-pillar trim just above the D-ring. The total amount of spool-out from the retractor from the tensioner-retracted position was no more than 11 cm, as measured by a second pull-string mounted between the retractor housing and the webbing beyond the retractor. Postcrash investigation of the force-limiting torsion bar within the retractor spool indicated it was twisted about 72 degrees from its precrash orientation. This measure, combined with the estimated diameter of the retractor spool and stowed webbing (52 mm), suggested that 3 cm of webbing spooled off the retractor from the force-limiting mechanism.

Seat

Postcrash examination of the driver seat rails indicated no discernible movement of the seat in its tracks during the crash. Deformation of the floor under the driver seat caused the seat to tip outboard and forward.

Steering Column

The upper end of the steering column moved upward 3 cm and rearward 3 cm relative to the driver seat.

Dummy Kinematics

Head, Neck, and Torso

Analysis of the high-speed film taken from camera position D indicated the dummy began to load the airbag at 78 ms, 12 ms after the airbag was fully deployed. Paint transferred from the dummy's face indicated the nose loaded the airbag 10 cm directly above its center. The dummy's head continued to move forward, and although the airbag fabric obscured the dummy's face, it appeared to contact the steering wheel. Sudden increases in the head rearward and rightward accelerations at 129 ms were consistent with contact between the dummy's head and steering wheel. On rebound from the steering wheel, the head moved upward, rearward, and outward. The top of the head brushed the roof rail interior trim and the adjacent window frame ahead of the B-pillar at 268 ms, according to the head acceleration data. Table 2 provides the timing of these events.

Table 2 Restraint System Performance and Dummy Kinematics — 2003 Lincoln Town Car	
Event	**Time (ms)**
Deployment of driver front airbag	34
Airbag fully inflated	66
Face begins to load airbag	78
Face contacts steering wheel through airbag	129
Top of head contacts roof rail and window frame	268

Figure 3
Dummy and Vehicle Interior, Postcrash — 2003 Lincoln Town Car

Figure 4
Dummy Left Knee/Shin Contacts, Postcrash — 2003 Lincoln Town Car

Figure 5
Dummy Right Knee/Shin Contacts, Postcrash — 2003 Lincoln Town Car

Figure 6
Dummy Feet Positions, Postcrash — 2003 Lincoln Town Car

Dummy Injury Measures

Head

The maximum vector resultant head accelerations were recorded and the HICs were calculated during an interval that corresponds with the dummy's head contact with the airbag and steering wheel. The maximum resultant head accelerations were 53 g at 132 ms from the steering wheel contact and 15 g at 273 ms from the roof rail/window frame contact. Table 3 provides a summary of the maximum head injury measurements recorded during the crash.

Table 3
Head Injury Measurements — 2003 Lincoln Town Car

Measure	Published Tolerance Threshold	Result	Time (ms)
Vector resultant acceleration (g)	80	53	132
Vector resultant acceleration — 3 ms clip (g)	80	51	131-134
Head injury criterion (HIC)	1000	484	105-141
Head injury criterion — 15 ms interval (HIC-15)	700	265	121-136

Neck

Table 4 provides a summary of the maximum neck injury measurements recorded during the crash. None of the recorded neck force measures exceeded the magnitude-duration injury criteria (Figures A-13 to A-16).

Table 4
Neck Injury Measurements — 2003 Lincoln Town Car

Measure	Published Tolerance Threshold	Result	Time (ms)
A-P shear force (kN)	±3.1	–0.4	197
Axial compression force (kN)	4.0	0.6	156
Axial tension force (kN)	3.3	1.5	127
N_{ij} tension-extension	1.00	0.22	127
N_{ij} tension-flexion	1.00	0.26	121
N_{ij} compression-extension	1.00	0.10	156
N_{ij} compression-flexion	1.00	0.14	156
Flexion bending moment (Nm)		27	104
Extension bending moment (Nm)		10	268

Chest

Table 5 provides a summary of the maximum chest injury measurements recorded during the crash.

Table 5
Chest Injury Measurements — 2003 Lincoln Town Car

Measure	Published Tolerance Threshold	Result	Time (ms)
Vector resultant spine acceleration — 3 ms clip (g)	60	47	126-129
Rib compression (mm)	–50	–36	130
Viscous criteria (m/s)	1.0	0.3	120
Sternum deflection rate (m/s)	–8.2	–1.2	120

Legs and Feet

Left leg and foot: The maximum left femur axial force was –7.5 kN at 118 ms and remained above –6.0 kN for 11 ms. The maximum left upper tibia A-P moment was 194 Nm at 117 ms, significantly contributing to the left upper tibia index of 0.97 at 118 ms. The maximum left tibia axial force was –4.2 kN at 74 ms. The maximum left tibia-femur displacement was –13 mm at 119 ms.

Right leg and foot: None of the injury measures exceeded published threshold values.

Table 6 provides a summary of the maximum leg and foot injury measurements recorded during the crash.

Table 6
Leg and Foot Injury Measurements — 2003 Lincoln Town Car

Measure	Published Tolerance Threshold	Left		Right	
		Result	Time (ms)	Result	Time (ms)
Femur axial force (kN)	–9.1*	–7.5	118	–2.6	118
Tibia-femur displacement (mm)	–15	–13	119	0	125
Upper Tibia					
L-M moment (Nm)	±225	–97	118	52	86
A-P moment (Nm)	±225	194	117	51	138
Vector resultant moment (Nm)	225	217	117	63	131
Index	1.00	0.97	118	0.34	131
Lower Tibia					
L-M moment (Nm)	±225**	–22	154	–68	88
A-P moment (Nm)	±225**	36	120	–39	101
Vector resultant moment (Nm)	225**	40	120	68	88
Axial force (kN)	–8.0**	–4.2	74	–2.4	129
Index	1.00	0.26	73	0.33	88
Foot					
A-P acceleration (g)	±150	–72	73	–45	74
I-S acceleration (g)	±150	–48	73	–46	84
Vector resultant acceleration (g)	150	87	73	60	101

* This critical value is for instantaneous loading. Femur loads are compared with magnitude-duration injury criteria in Figures A-24 and A-37.

** These published thresholds are for fractures of the tibia. Ankle and foot injuries have been associated with bending moments as low as 50-100 Nm, and heel fractures have been associated with axial forces as low as –6.0 kN.

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Appendix

Dummy Clearance Measurements

Graph Index — index to graphs of time plots of dummy and vehicle data

Manufacturer's window sticker

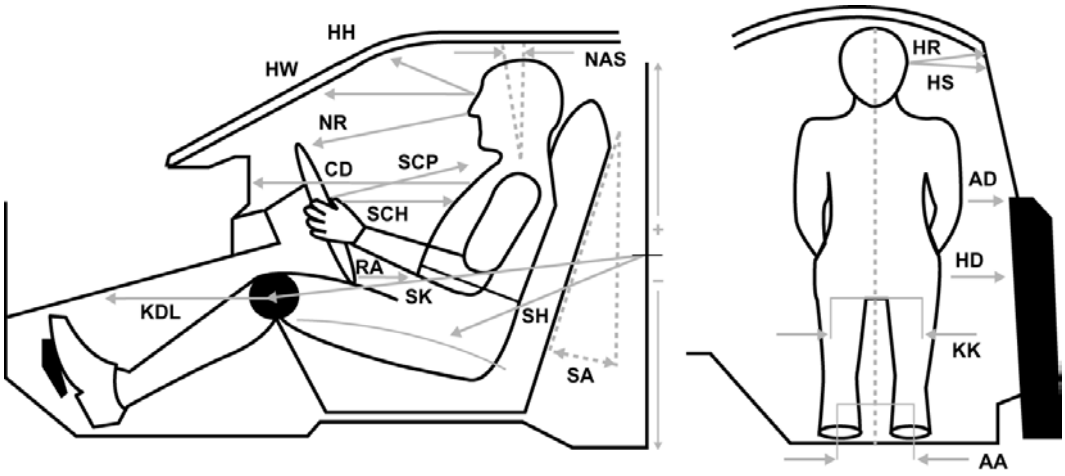
Dummy Clearance Measurements

Test Number: CEF0313
Vehicle Make/Model: Lincoln Town Car
Vehicle Model Year: 2003
Seat Type: Electrically adjusted bucket seat (fore/aft, height, and seat back angle)

Manufacturer's Specifications
Seat Back Information: Reclined to 29° relative to a perpendicular to the rocker sill, as measured on outboard rear frame of seat back
Upper Belt Anchorage: Set to 3rd of 5 positions (from top)
Steering Column Adjustment: Set to midpoint of tilt adjustment range (3rd of 5 tilt positions from top)
Foot Pedal Adjustment Set to fully forward position of fore/aft range

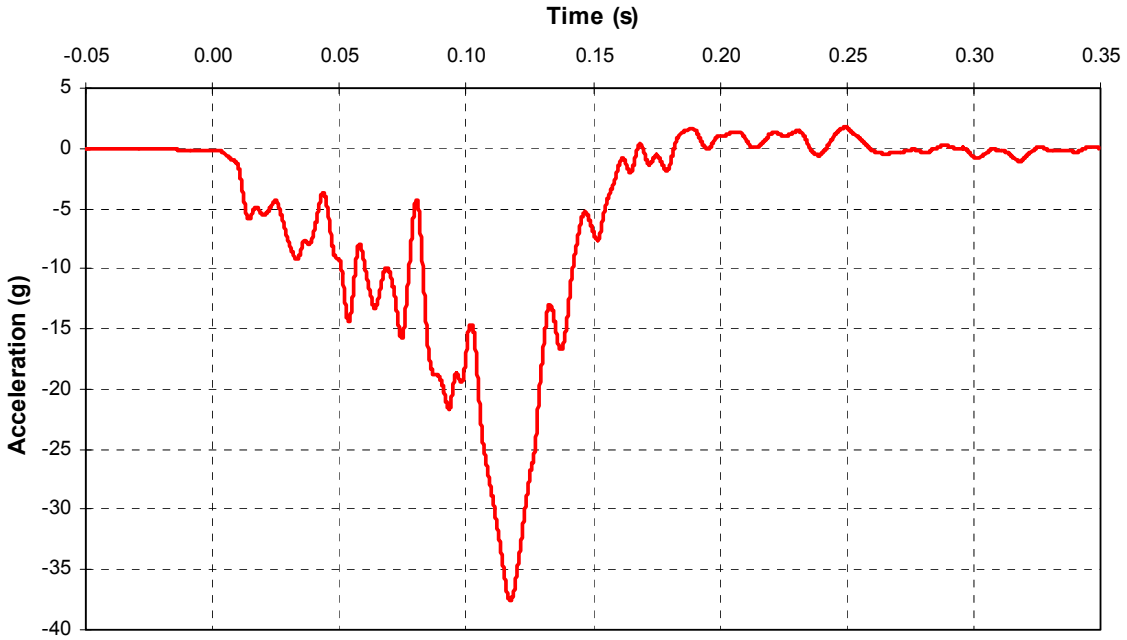
Location	Code	Measure	Location	Code	Measure
Head to header	HH	357	Neck angle, torso 90	NAT90	21.1°
Head to windshield	HW	591	Neck angle, seated	NAS	7.3°
Nose to rim	NR	383	Torso angle (NAT90 – NAS)	TA	13.8°
Chest to dash	CD	672	Striker to knee*	SK	535
Rim to abdomen	RA	198	Striker to knee angle*	SKA	2.2°
Knee to dash, left	KDL	216	Striker to H-point, horizontal	SHH	157
Knee to dash, right	KDR	158	Striker to H-point, vertical	SHV	–113
Steering wheel to chest, horizontal	SCH	300	Ankle to ankle	AA	338
Steering wheel to chest, perpendicular	SCP	374	Knee to knee	KK	365
Steering wheel to chest, reference	SCR	364	Arm to door	AD	25
Hub to chest, minimum	HCM	244	H-point to door	HD	185
Pelvic angle	PA	24.3°	Head to A-pillar	HA	508
Seat back angle	SA	29°	Head to roof	HR	175
			Head to side window	HS	265

All distance measurements are in millimeters (mm).
* These measurements were made in a vertical plane containing the striker and parallel to the driver door sill.

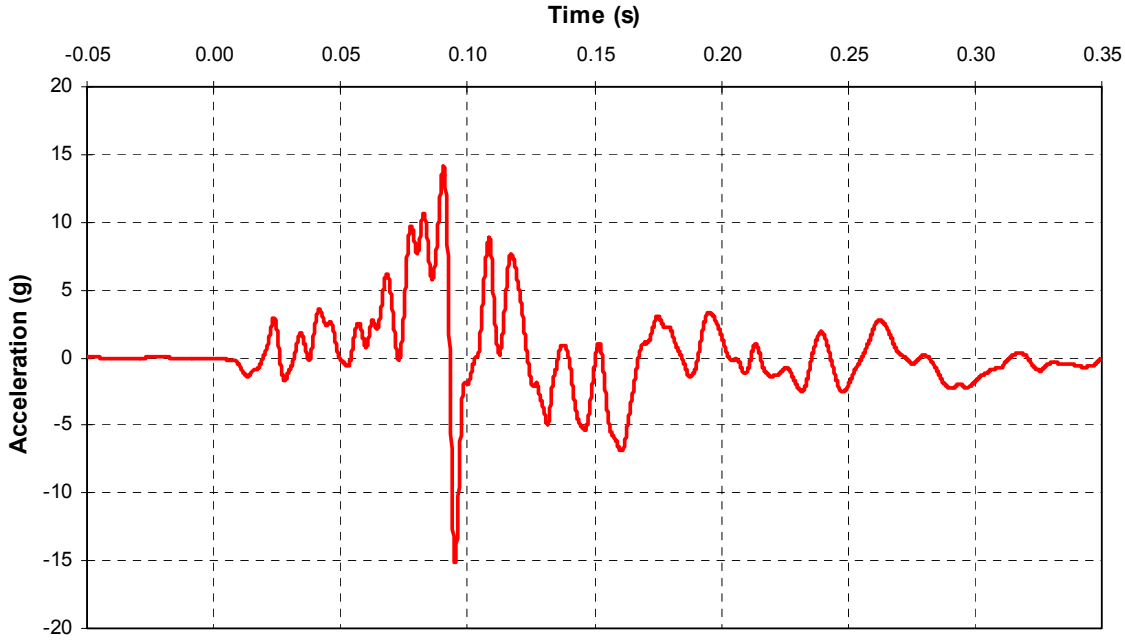


Graph Index

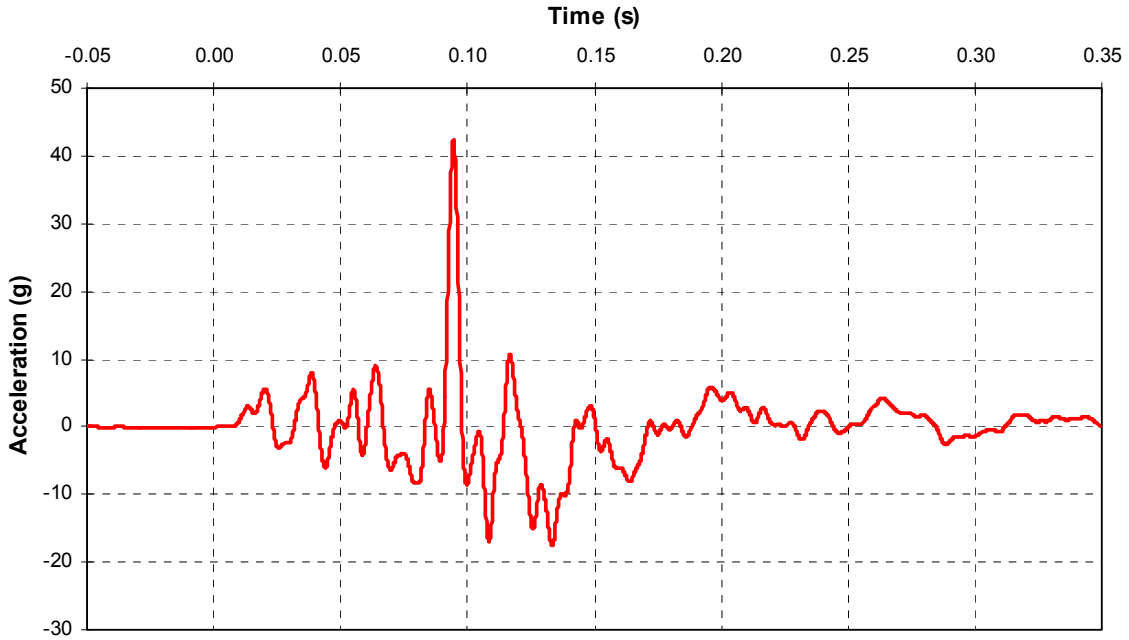
A- 1 CEF0313 2003 Lincoln Town Car Vehicle Longitudinal Acceleration



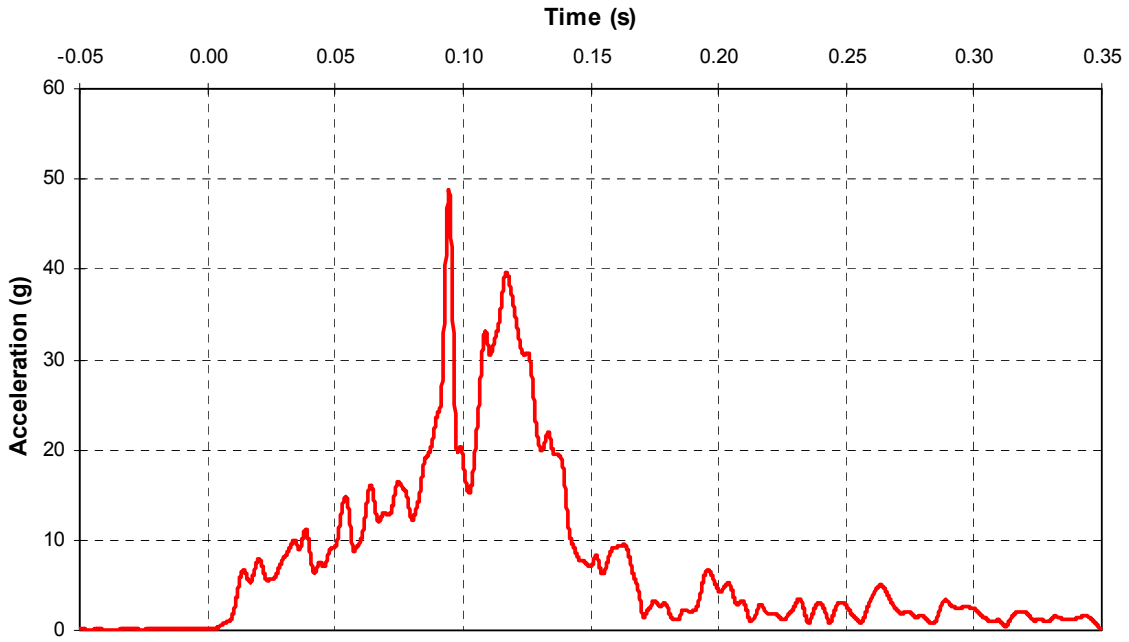
A- 2 CEF0313 2003 Lincoln Town Car Vehicle Lateral Acceleration



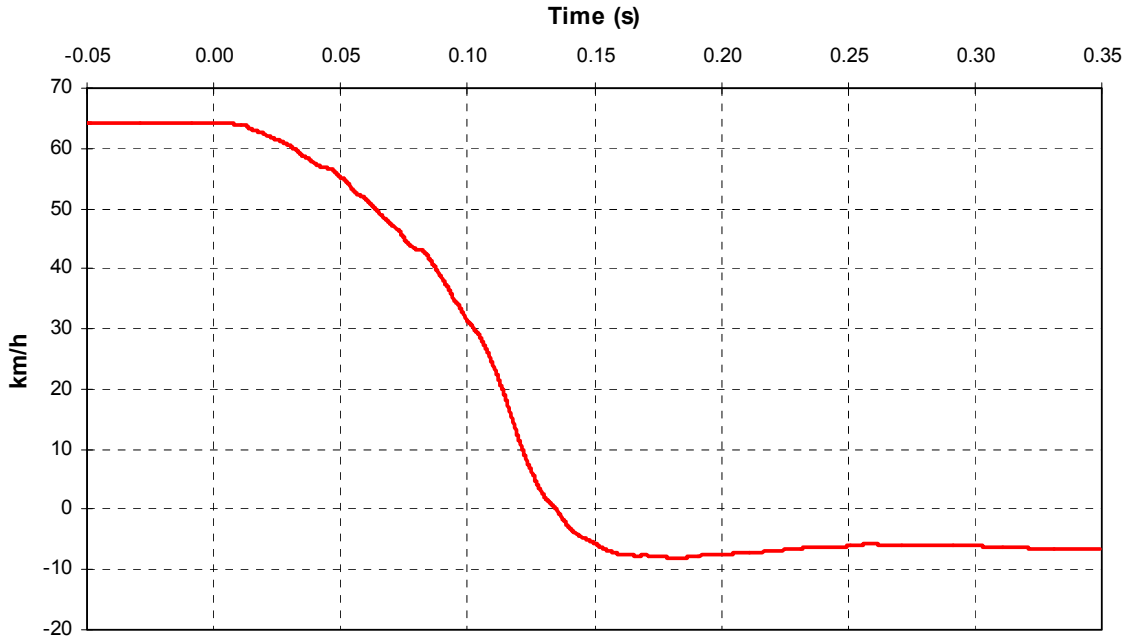
A- 3 CEF0313 2003 Lincoln Town Car Vehicle Vertical Acceleration



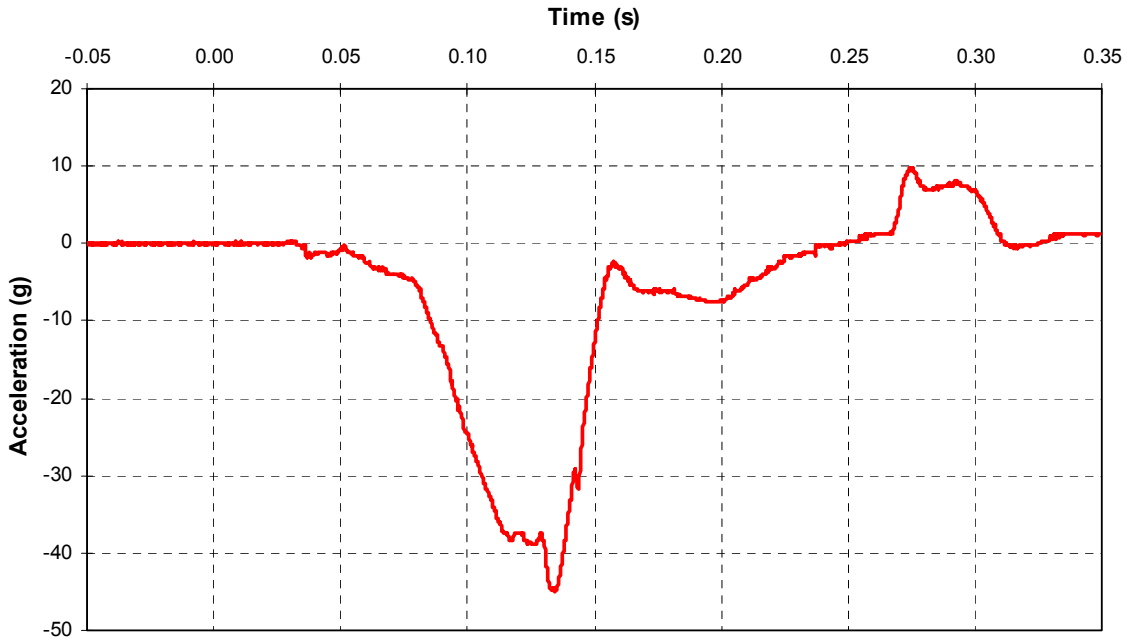
A- 4 CEF0313 2003 Lincoln Town Car Vehicle Vector Resultant Acceleration



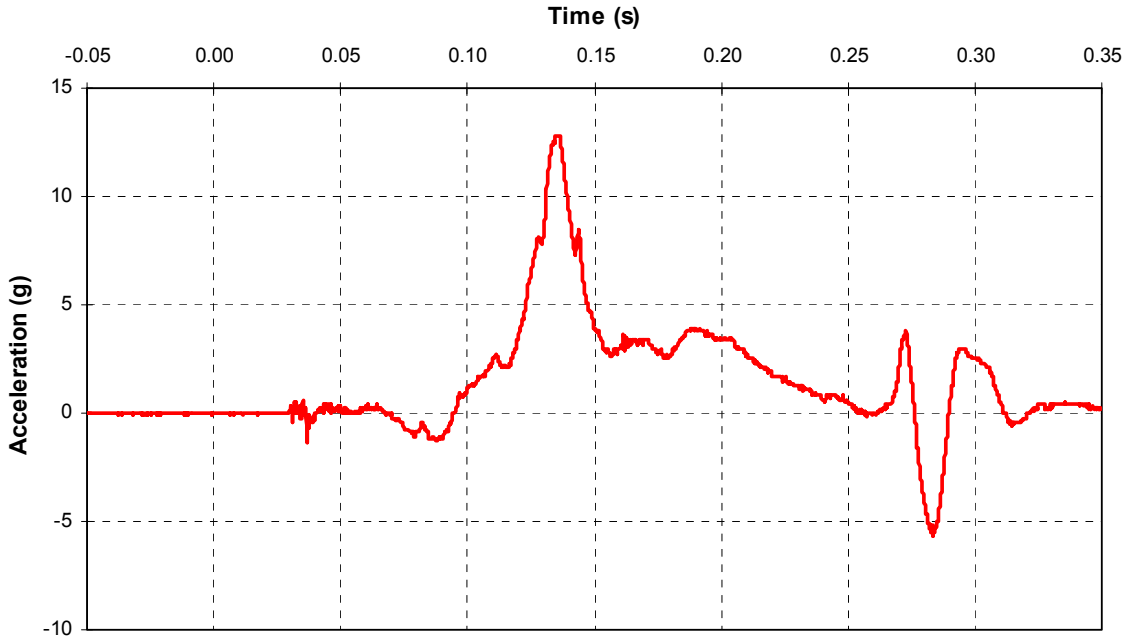
A- 5 CEF0313 2003 Lincoln Town Car Integration of Vehicle Longitudinal Acceleration



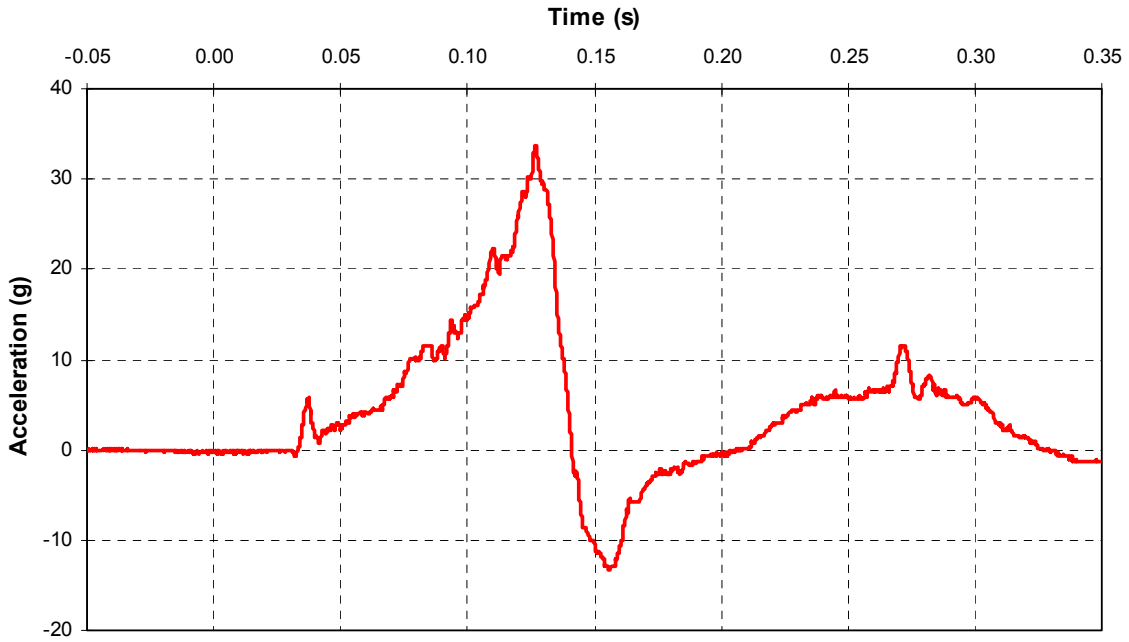
A- 6 CEF0313 2003 Lincoln Town Car Head A-P Acceleration



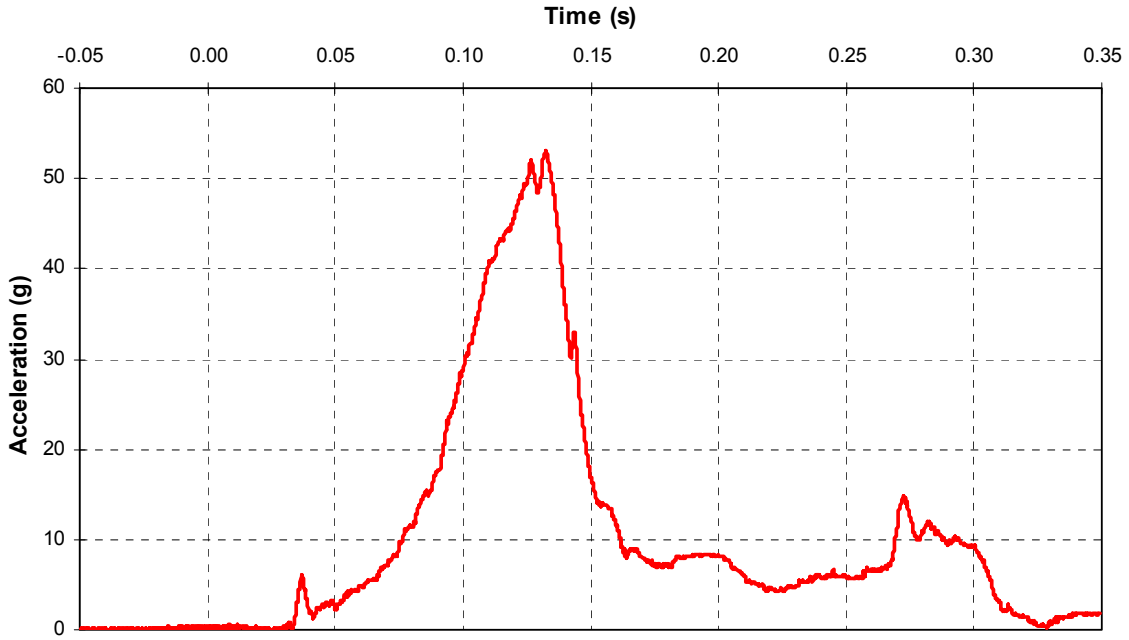
A- 7 CEF0313 2003 Lincoln Town Car Head L-M Acceleration



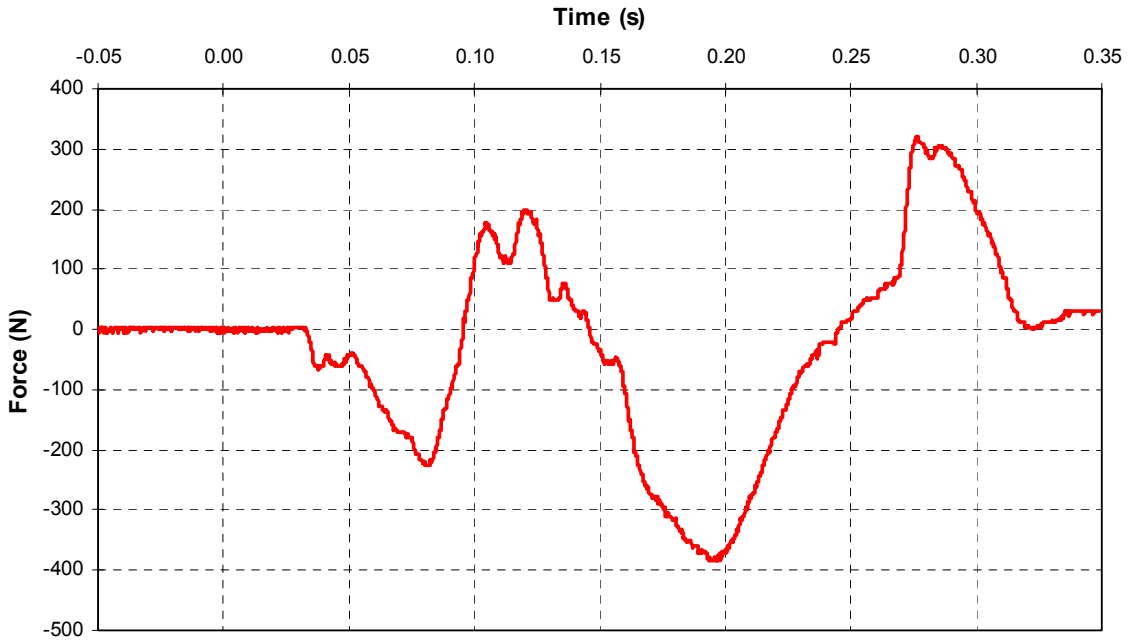
A- 8 CEF0313 2003 Lincoln Town Car Head l-S Acceleration



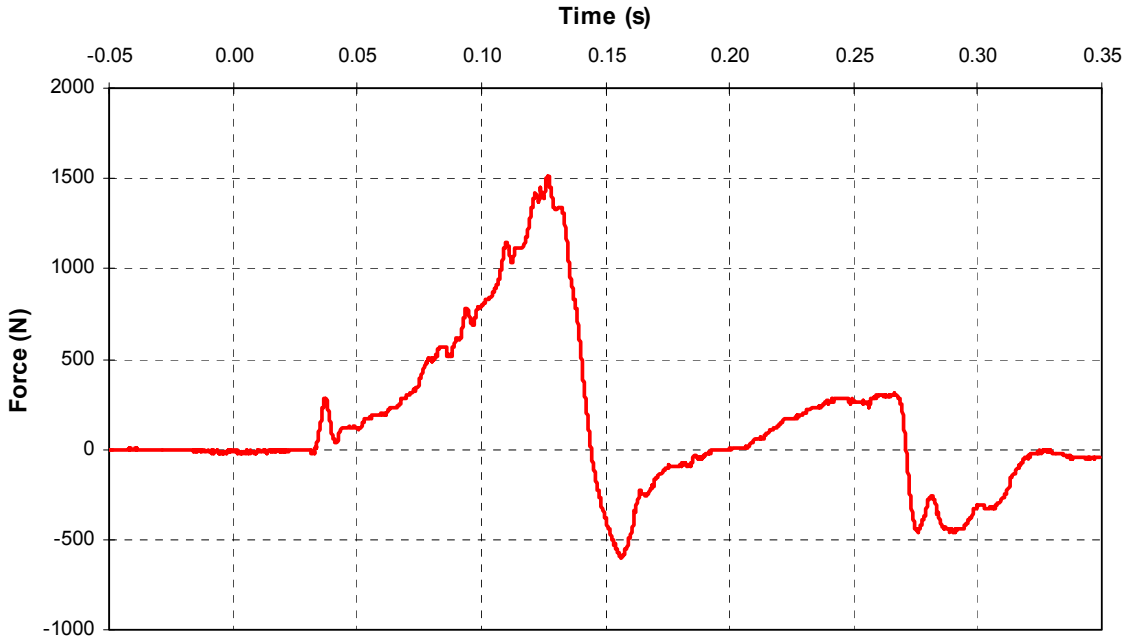
A- 9 CEF0313 2003 Lincoln Town Car Head Vector Resultant Acceleration



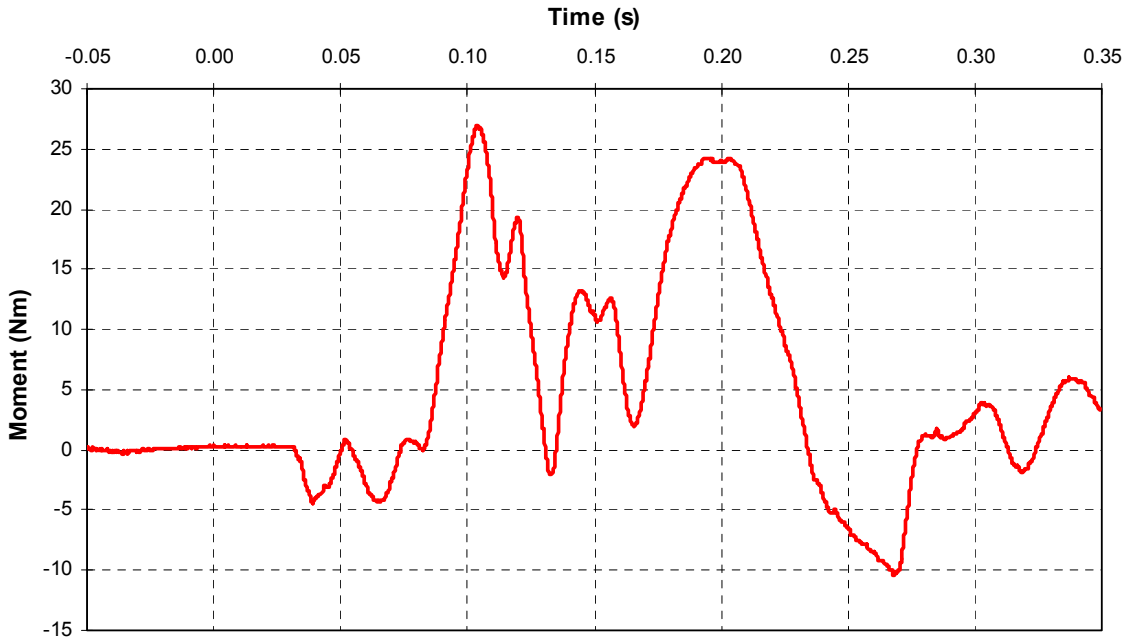
A- 10 CEF0313 2003 Lincoln Town Car Neck A-P Shear Force



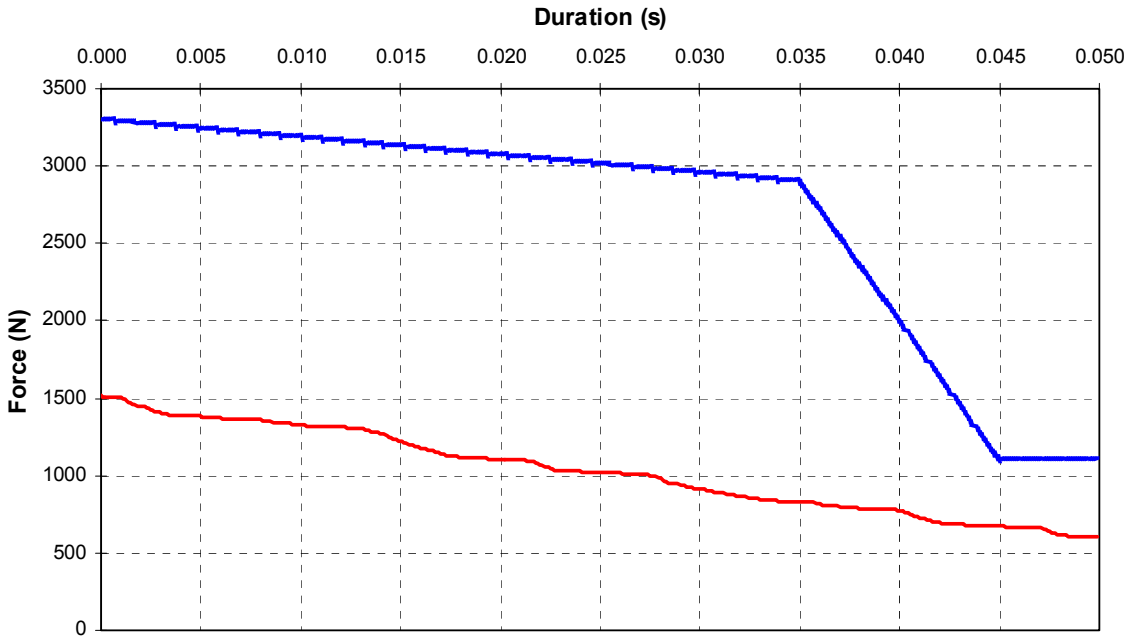
A- 11 CEF0313 2003 Lincoln Town Car Neck Axial Force



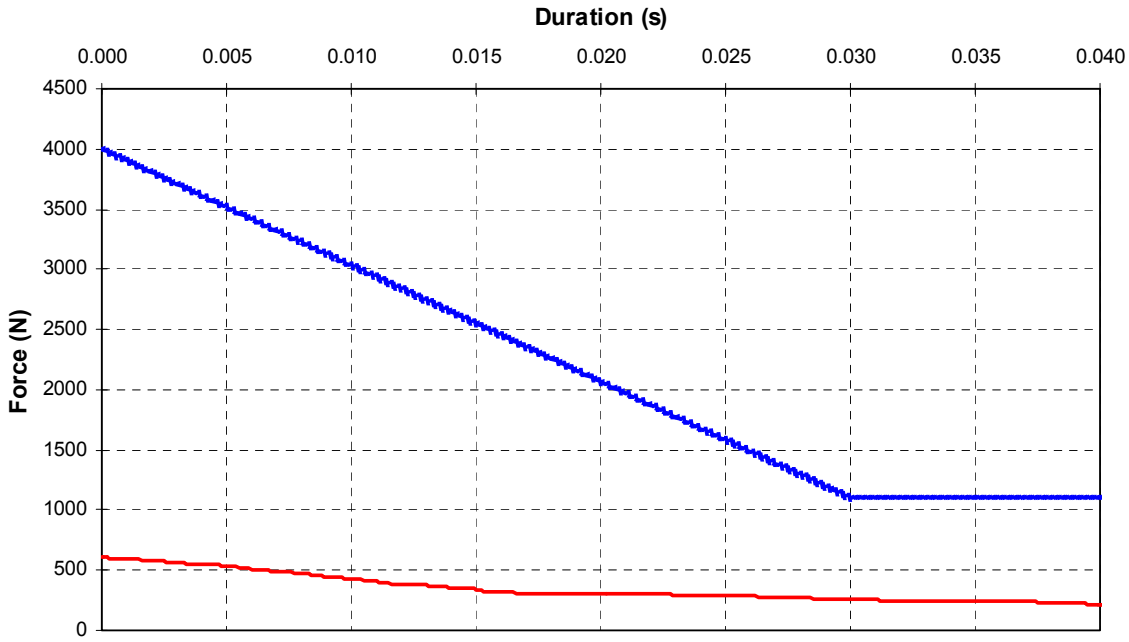
A- 12 CEF0313 2003 Lincoln Town Car Neck Occipital A-P Moment



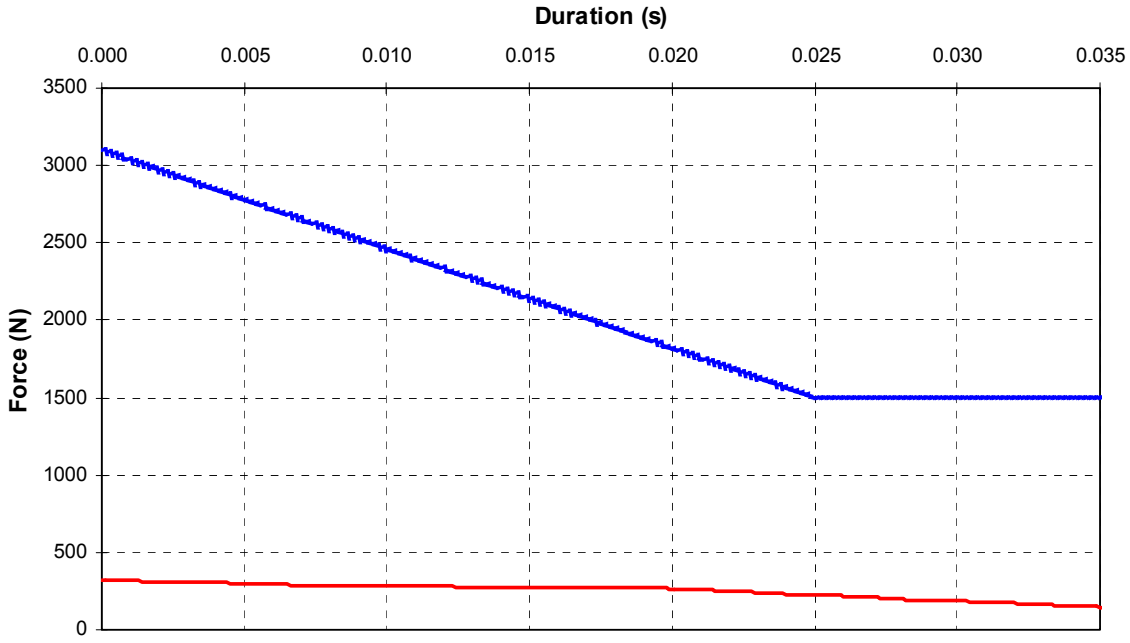
A- 13 CEF0313 2003 Lincoln Town Car Neck Tension Analysis



A- 14 CEF0313 2003 Lincoln Town Car Neck Compression Analysis



A- 15 CEF0313 2003 Lincoln Town Car Neck A-P Shear (Positive) Analysis



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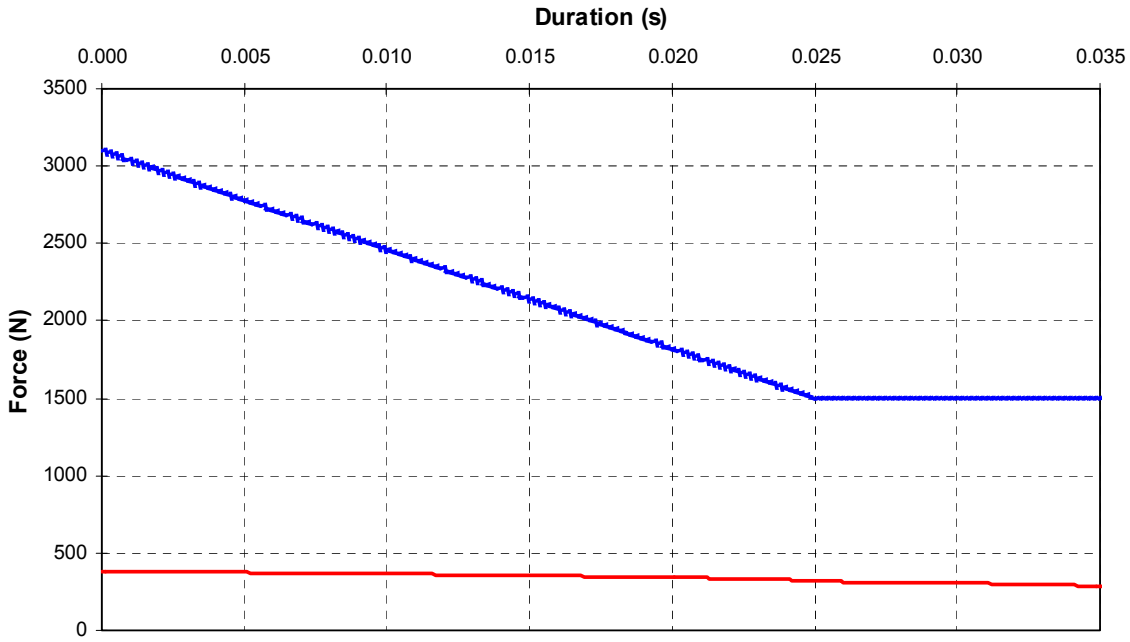
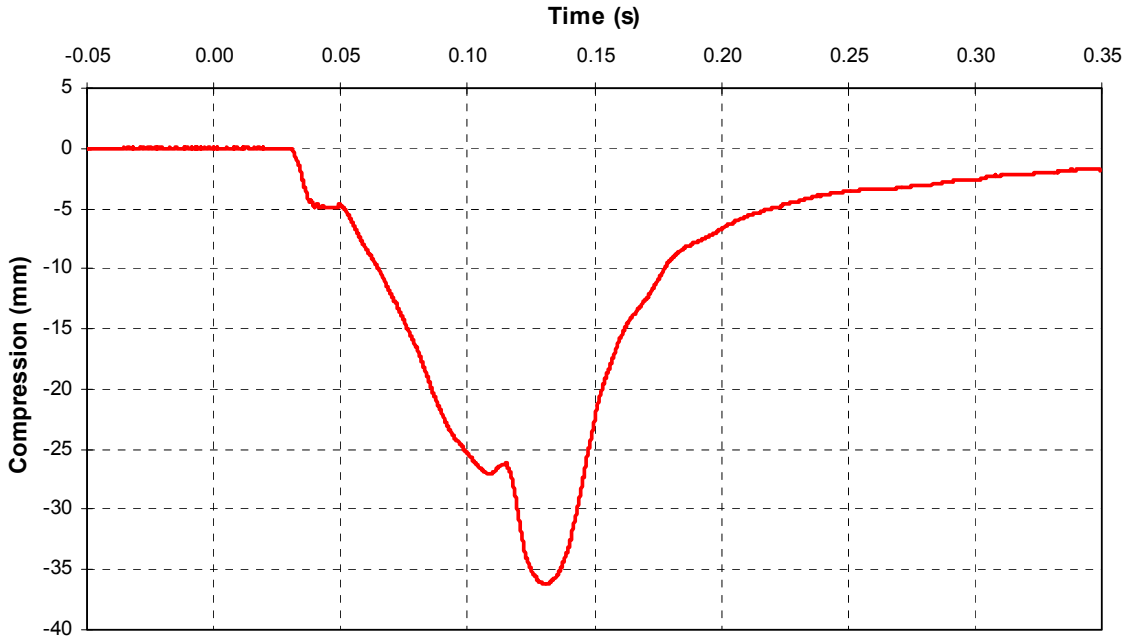
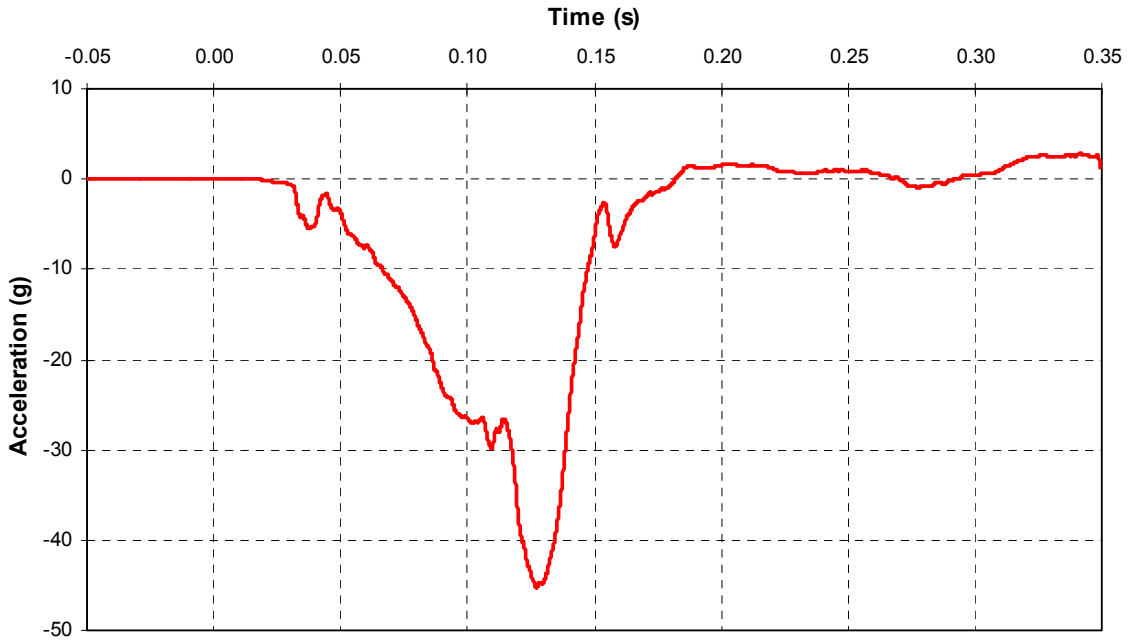


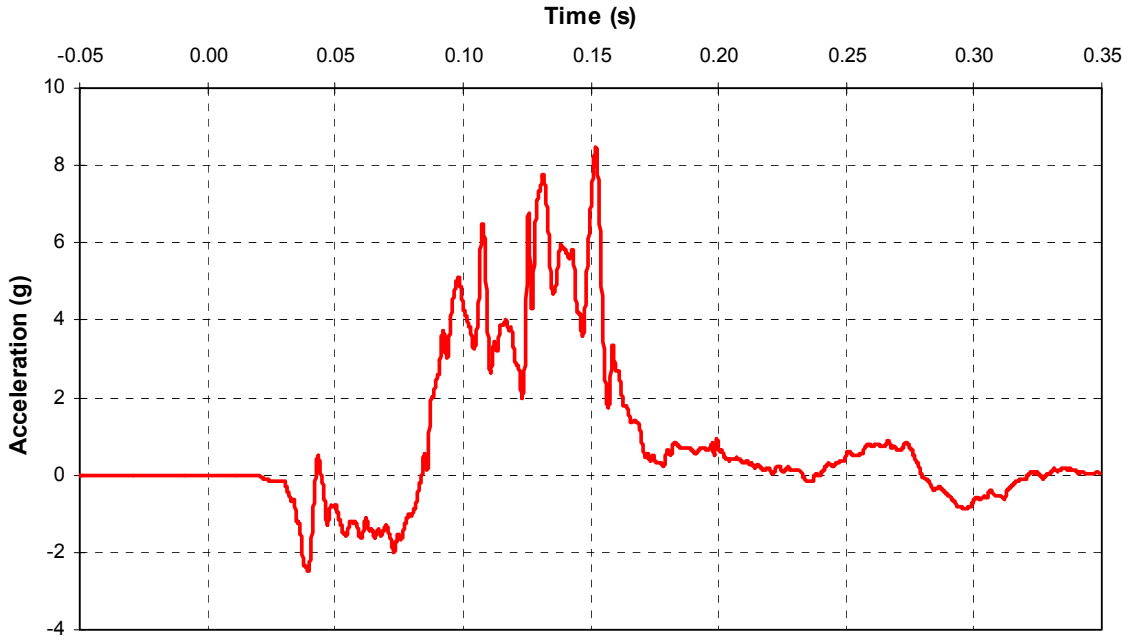
A- 17 CEF0313 2003 Lincoln Town Car Chest Compression



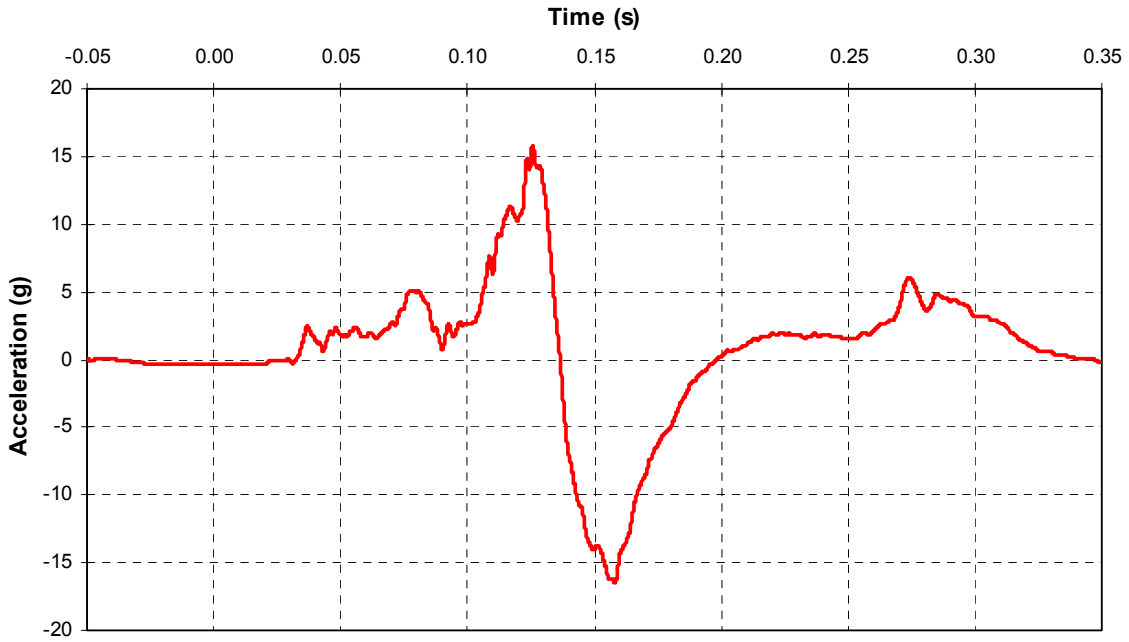
A- 18 CEF0313 2003 Lincoln Town Car Chest A-P Acceleration



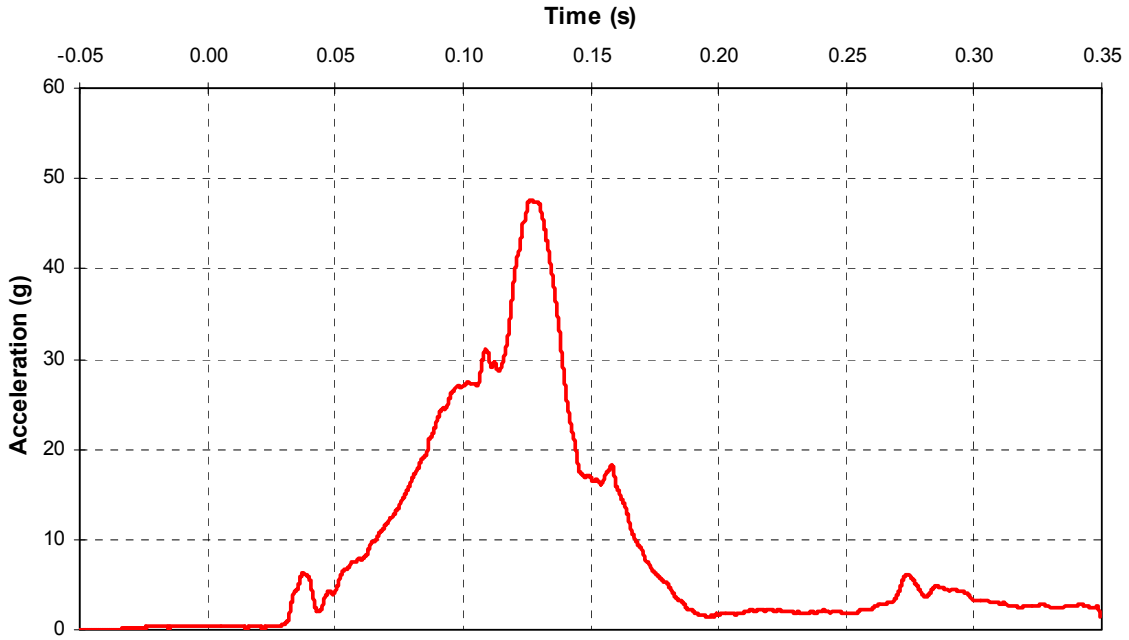
A- 19 CEF0313 2003 Lincoln Town Car Chest L-M Acceleration



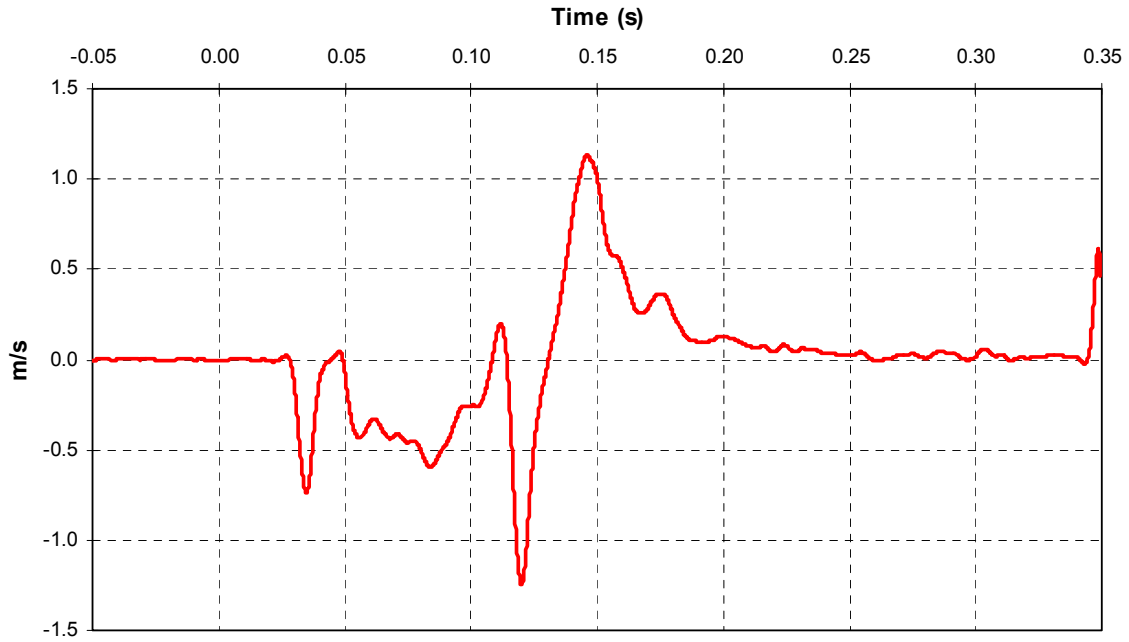
A- 20 CEF0313 2003 Lincoln Town Car Chest I-S Acceleration



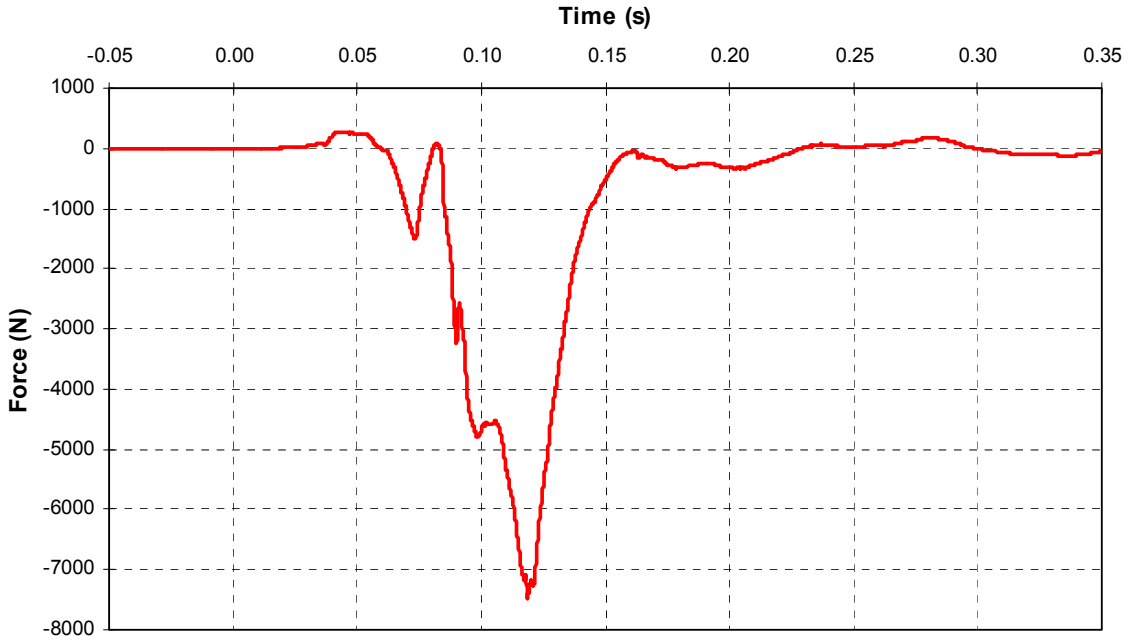
A- 21 CEF0313 2003 Lincoln Town Car Chest Vector Resultant Acceleration



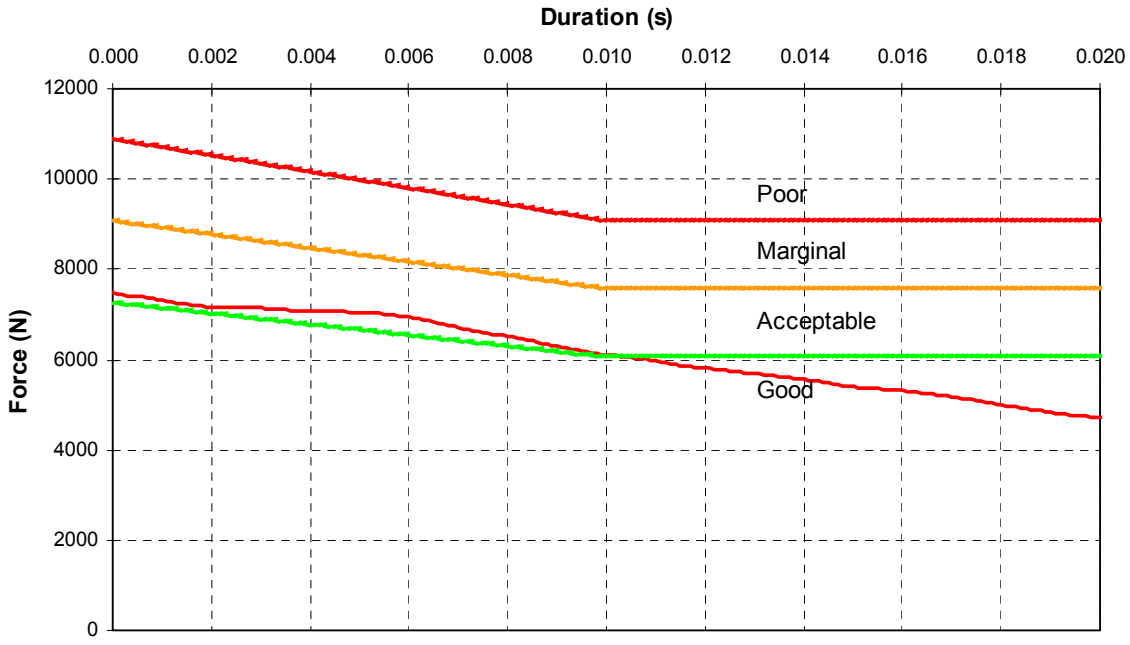
A- 22 CEF0313 2003 Lincoln Town Car Sternum Deflection Rate



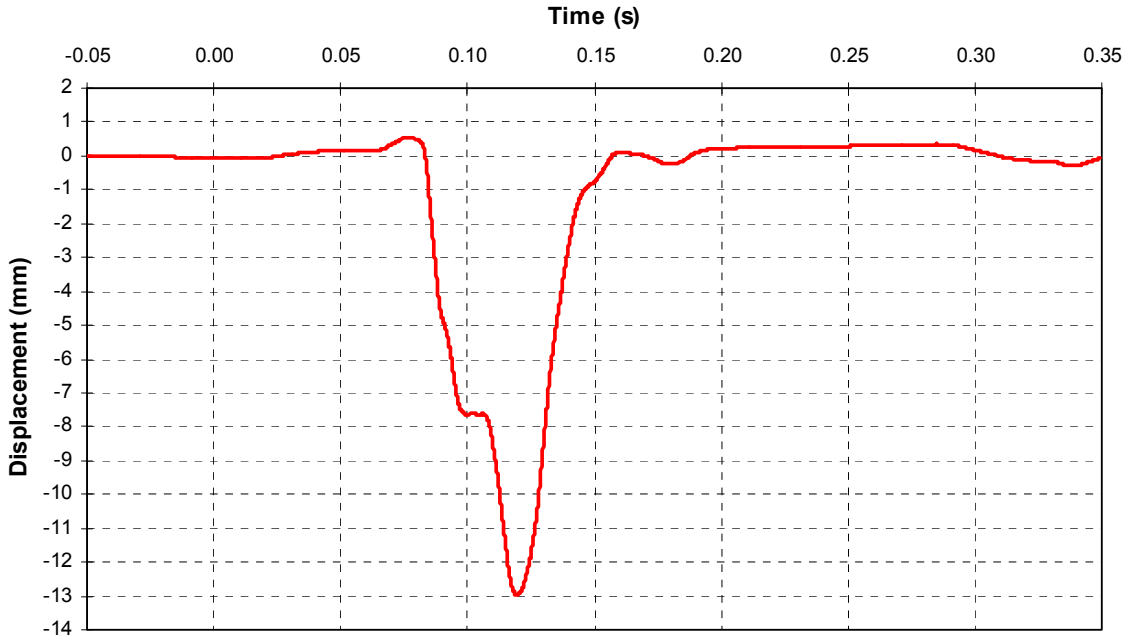
A- 23 CEF0313 2003 Lincoln Town Car Left Femur Axial Force



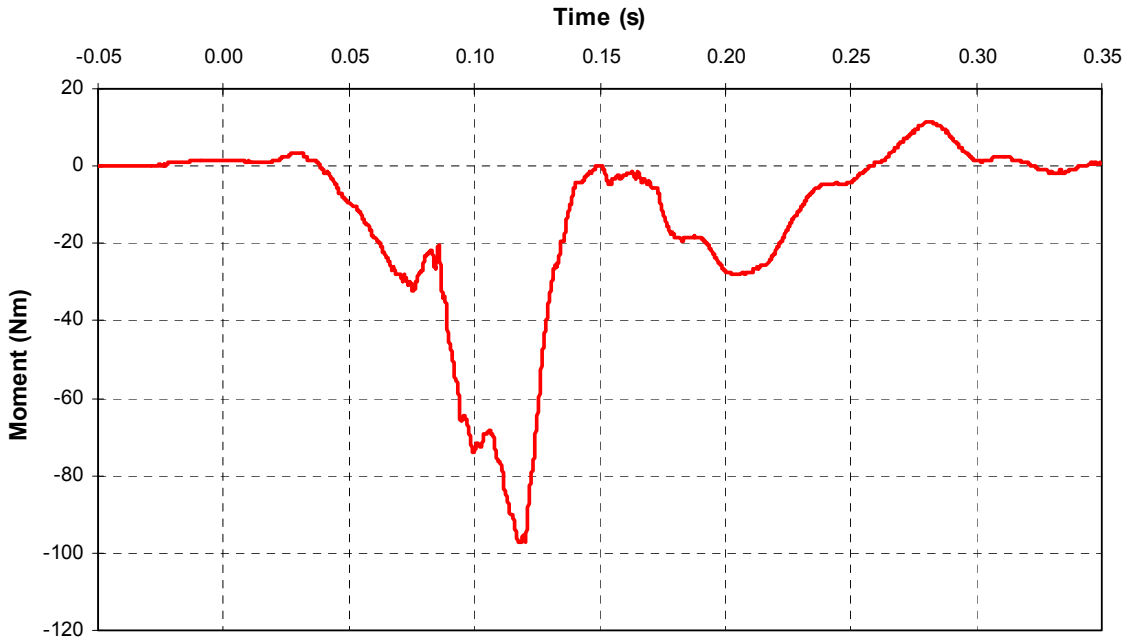
A- 24 CEF0313 2003 Lincoln Town Car Left Femur Axial Force Analysis



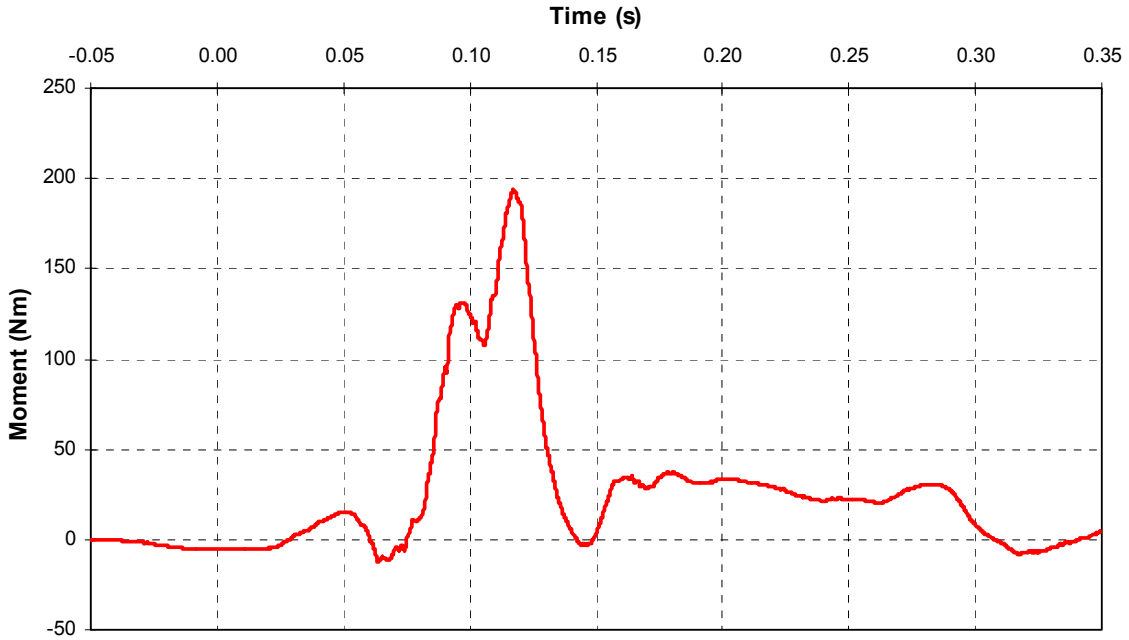
A- 25 CEF0313 2003 Lincoln Town Car Left Tibia-Femur Displacement



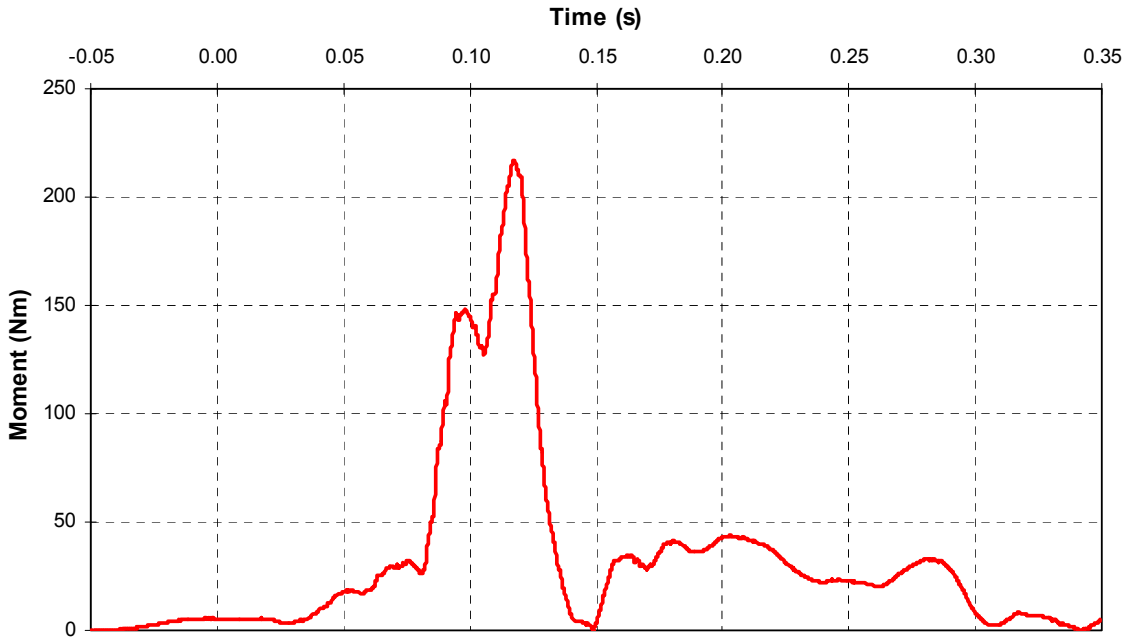
A- 26 CEF0313 2003 Lincoln Town Car Left Upper Tibia L-M Moment



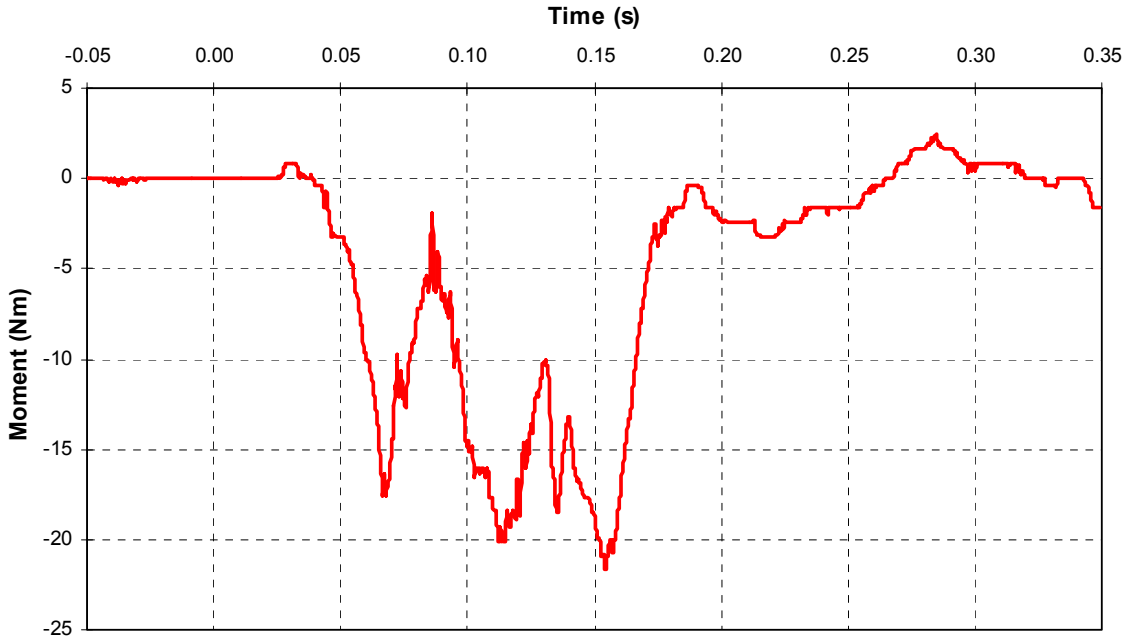
A- 27 CEF0313 2003 Lincoln Town Car Left Upper Tibia A-P Moment



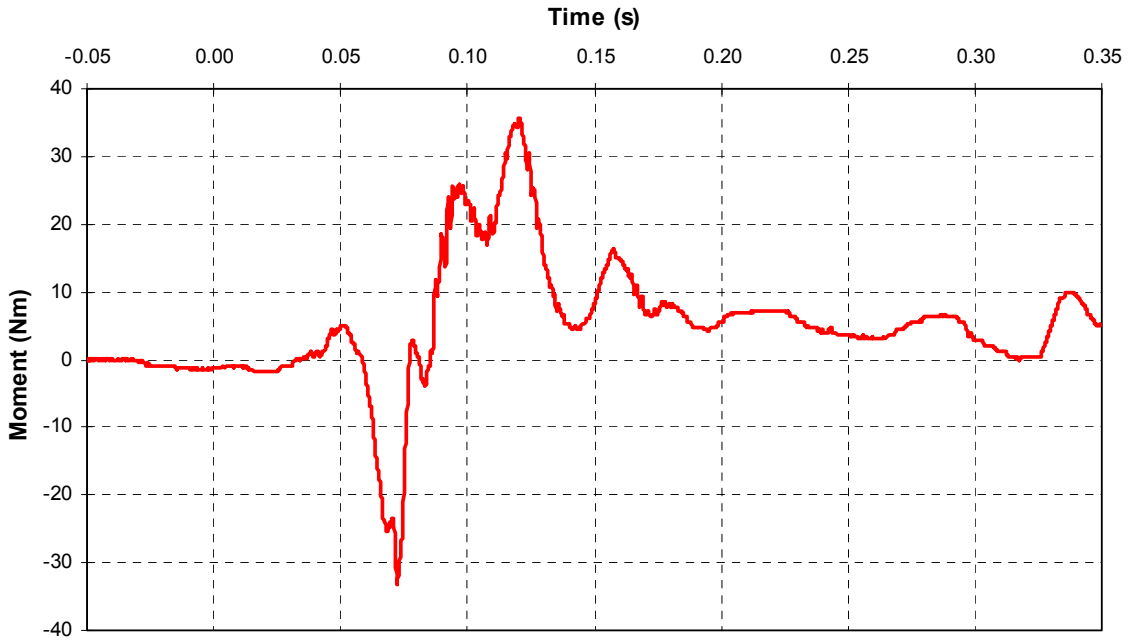
A- 28 CEF0313 2003 Lincoln Town Car Left Upper Tibia Vector Resultant Moment



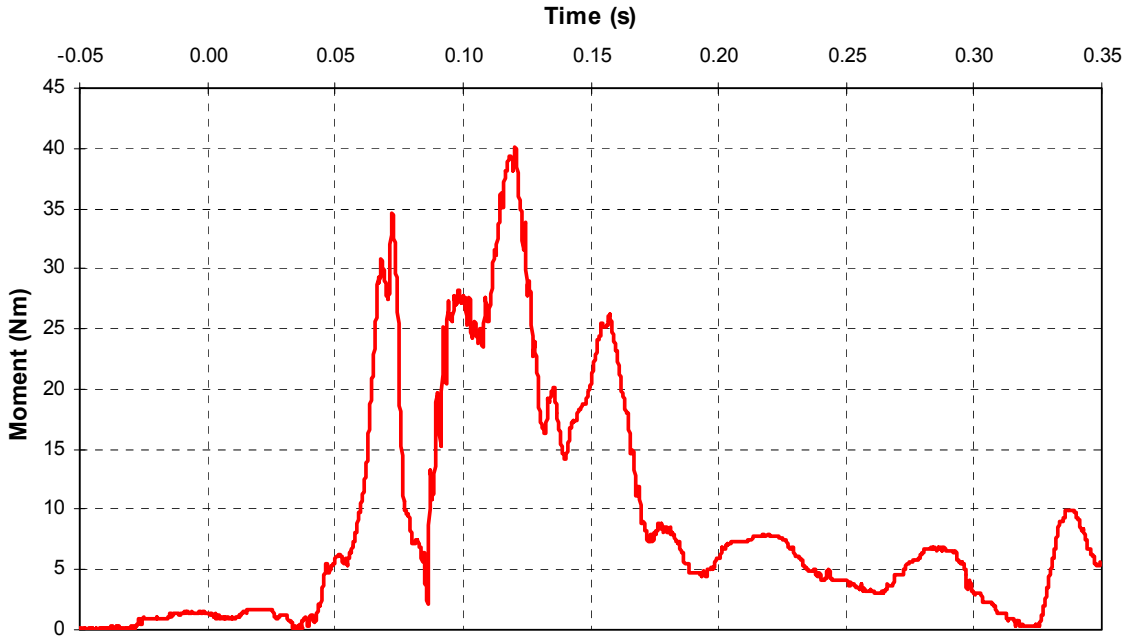
A- 29 CEF0313 2003 Lincoln Town Car Left Lower Tibia L-M Moment



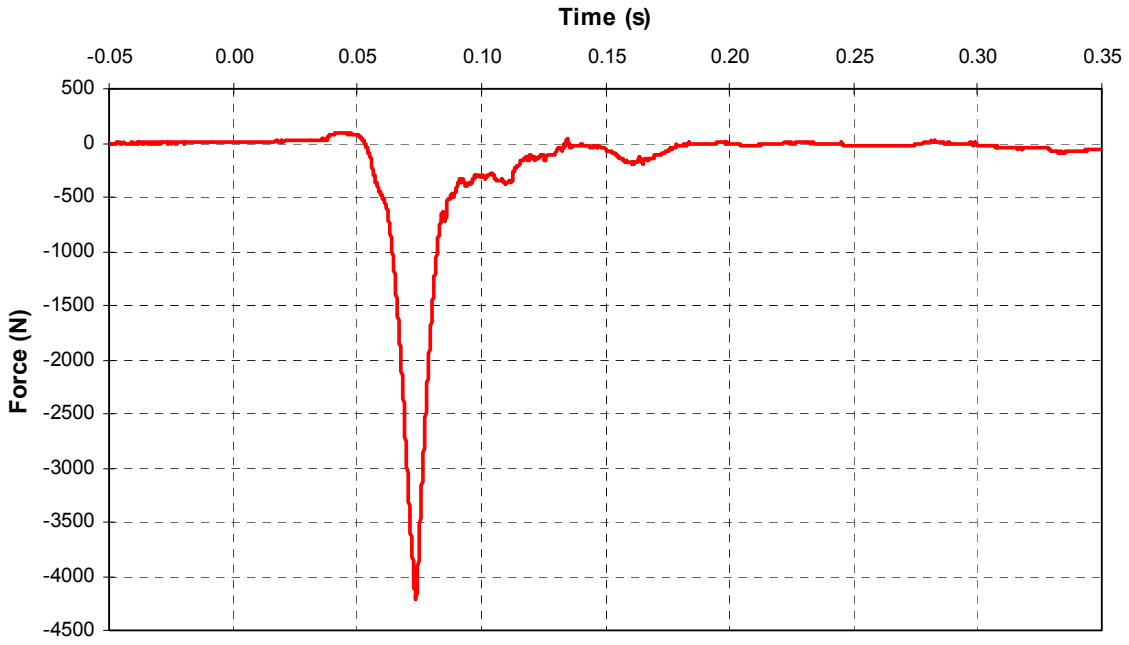
A- 30 CEF0313 2003 Lincoln Town Car Left Lower Tibia A-P Moment



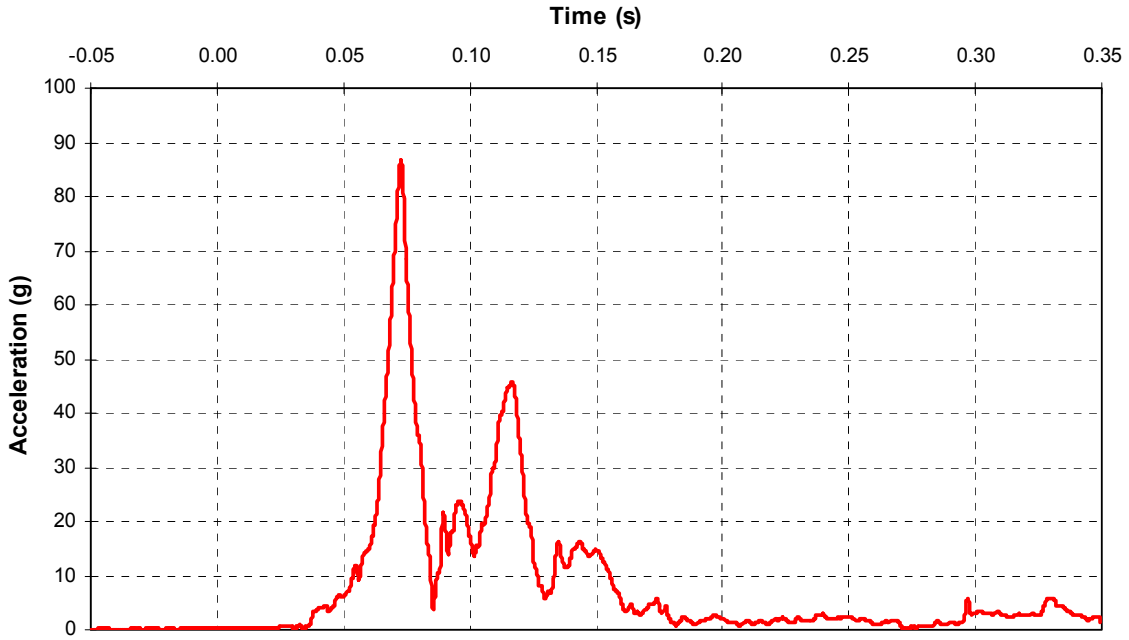
A- 31 CEF0313 2003 Lincoln Town Car Left Lower Tibia Vector Resultant Moment



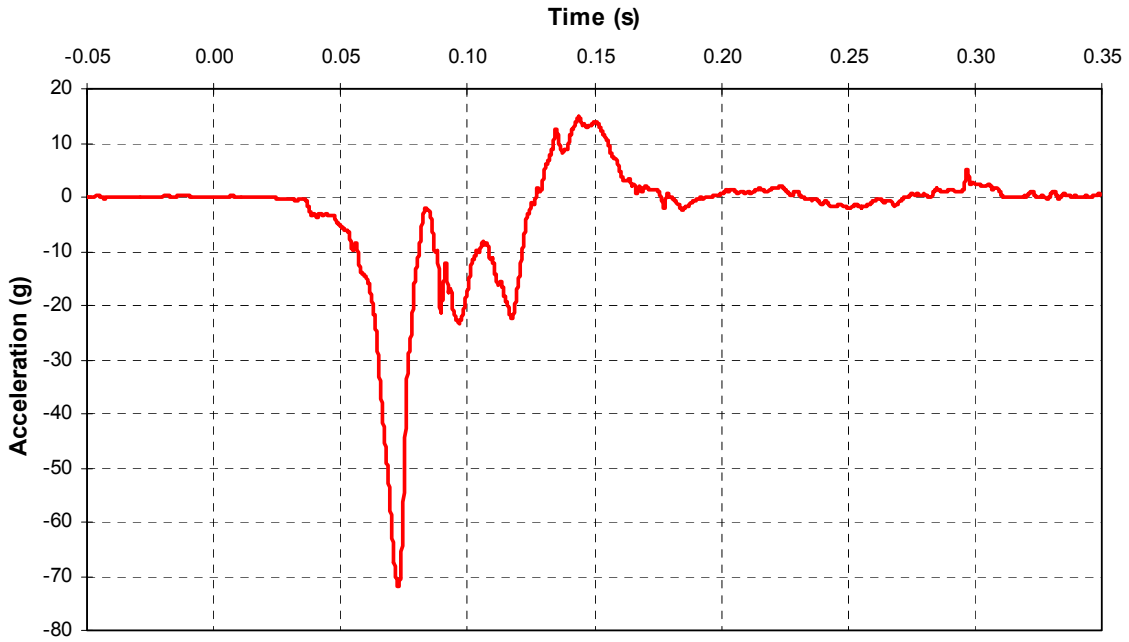
A- 32 CEF0313 2003 Lincoln Town Car Left Lower Tibia Axial Force



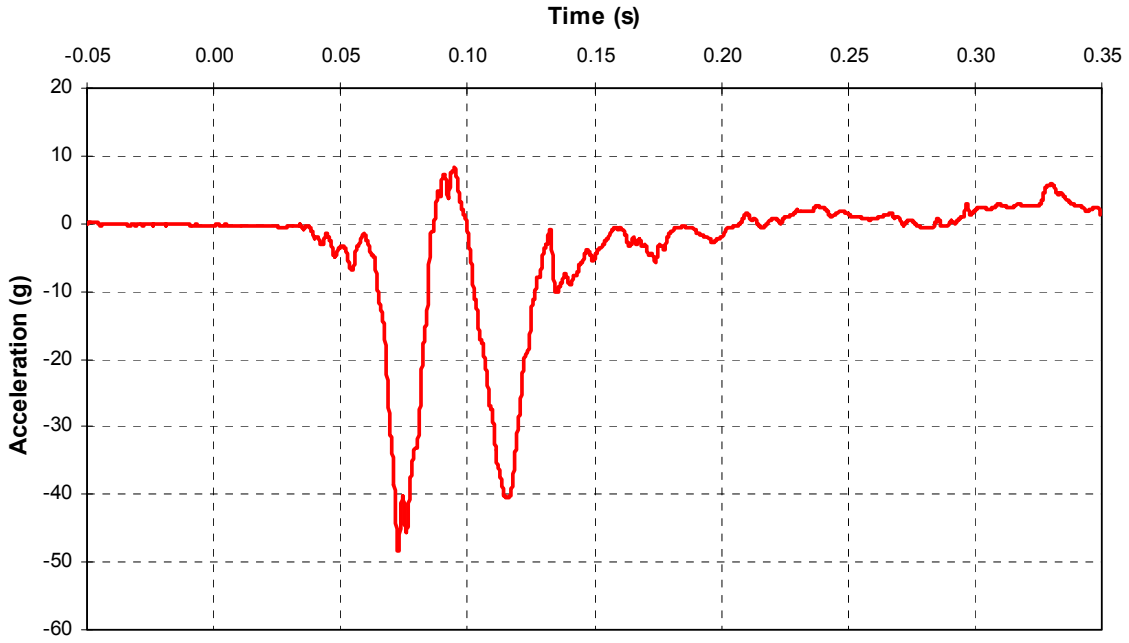
A- 33 CEF0313 2003 Lincoln Town Car Left Foot Vector Resultant Acceleration



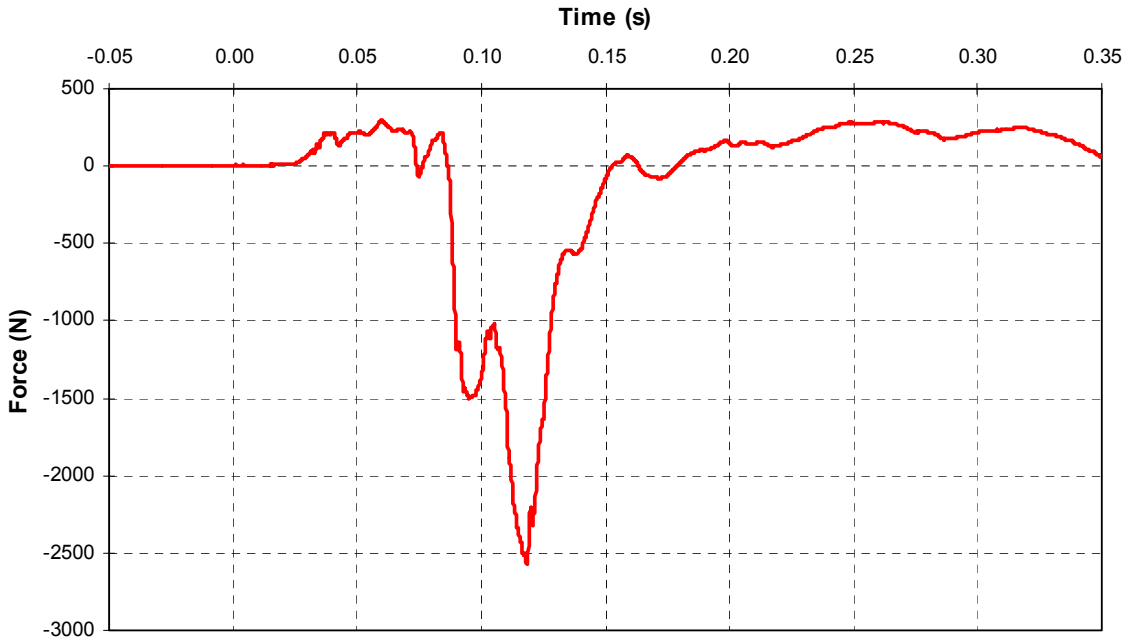
A- 34 CEF0313 2003 Lincoln Town Car Left Foot A-P Acceleration



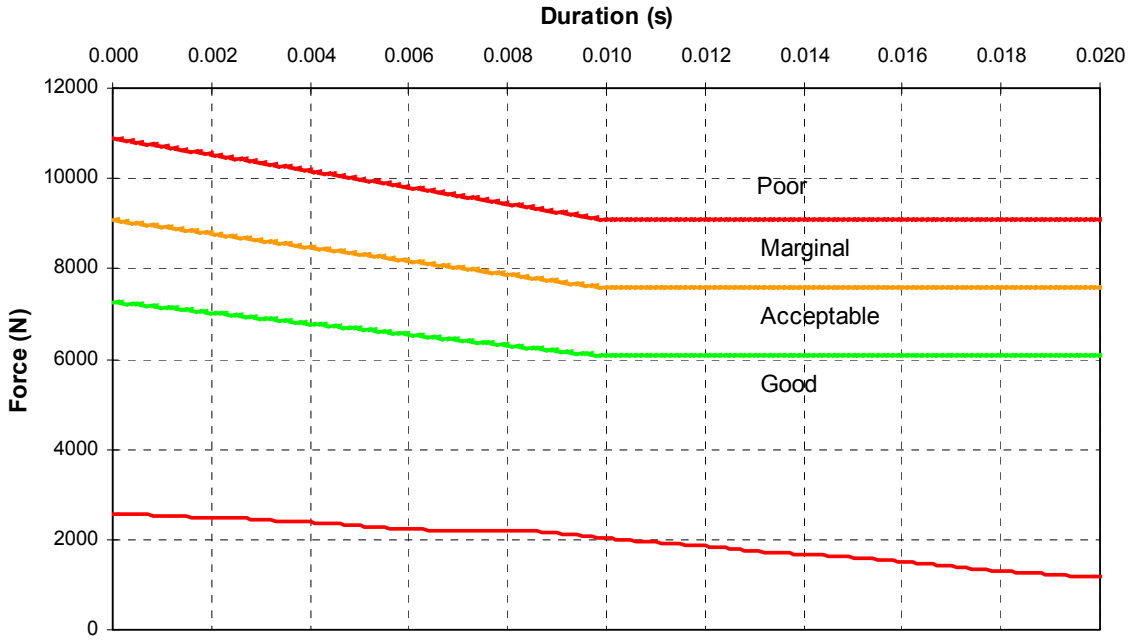
A- 35 CEF0313 2003 Lincoln Town Car Left Foot I-S Acceleration



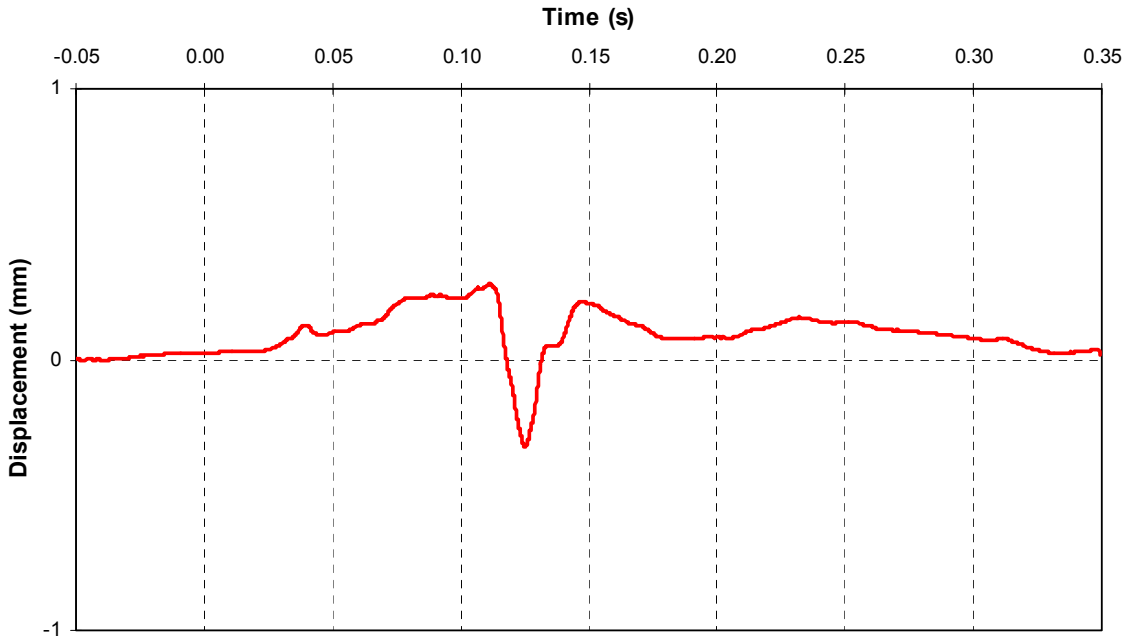
A- 36 CEF0313 2003 Lincoln Town Car Right Femur Axial Force



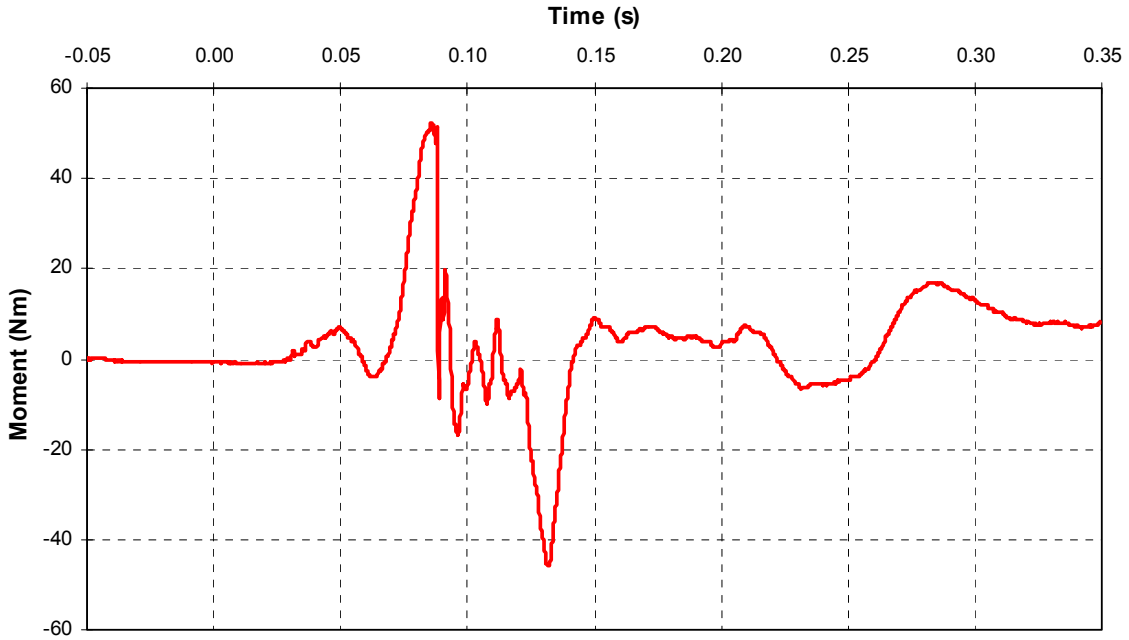
A- 37 CEF0313 2003 Lincoln Town Car Right Femur Axial Force Analysis



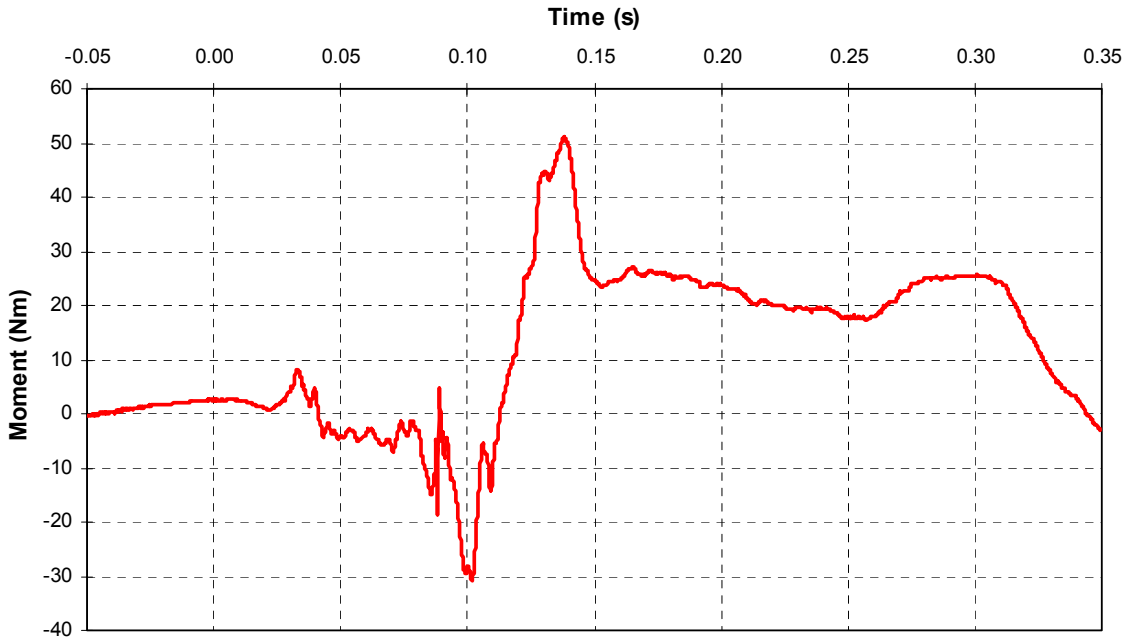
A- 38 CEF0313 2003 Lincoln Town Car Right Tibia-Femur Displacement



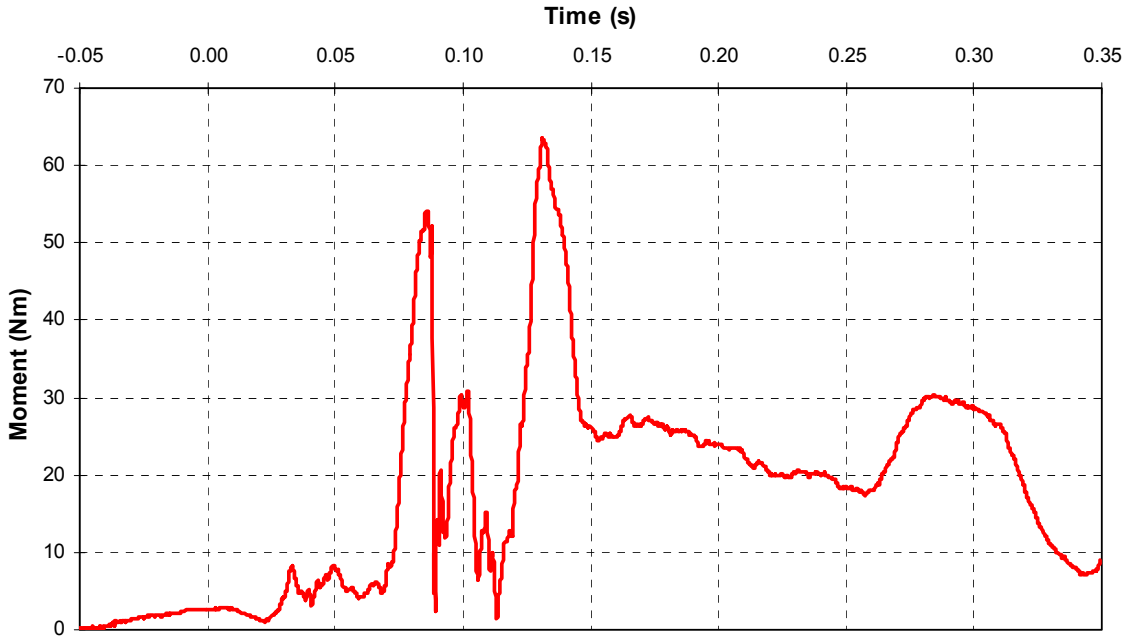
A- 39 CEF0313 2003 Lincoln Town Car Right Upper Tibia L-M Moment



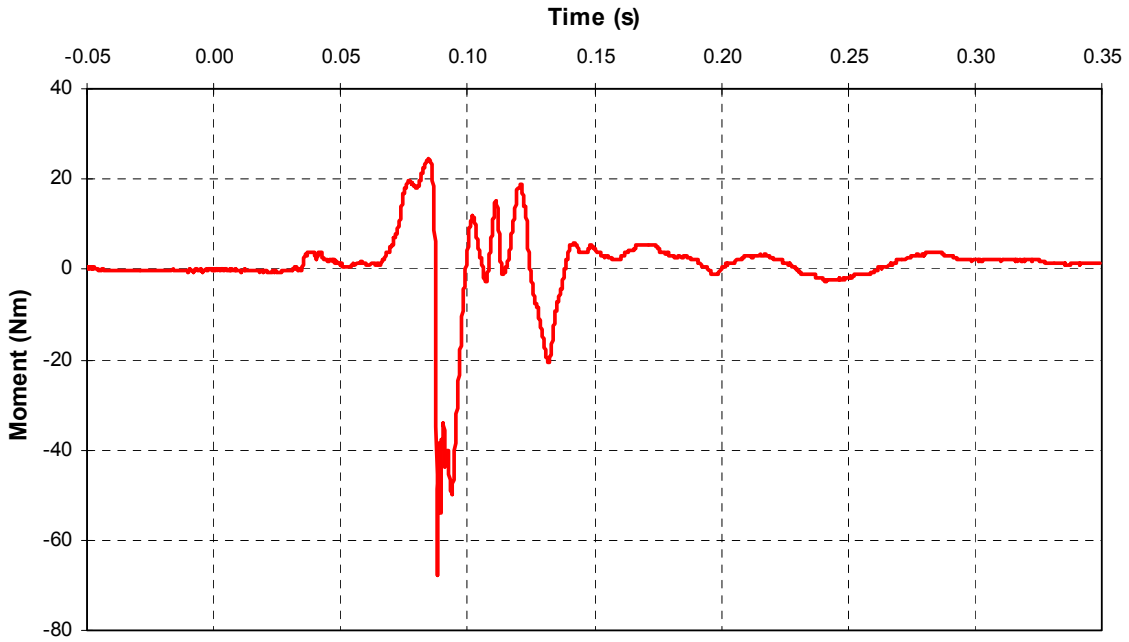
A- 40 CEF0313 2003 Lincoln Town Car Right Upper Tibia A-P Moment



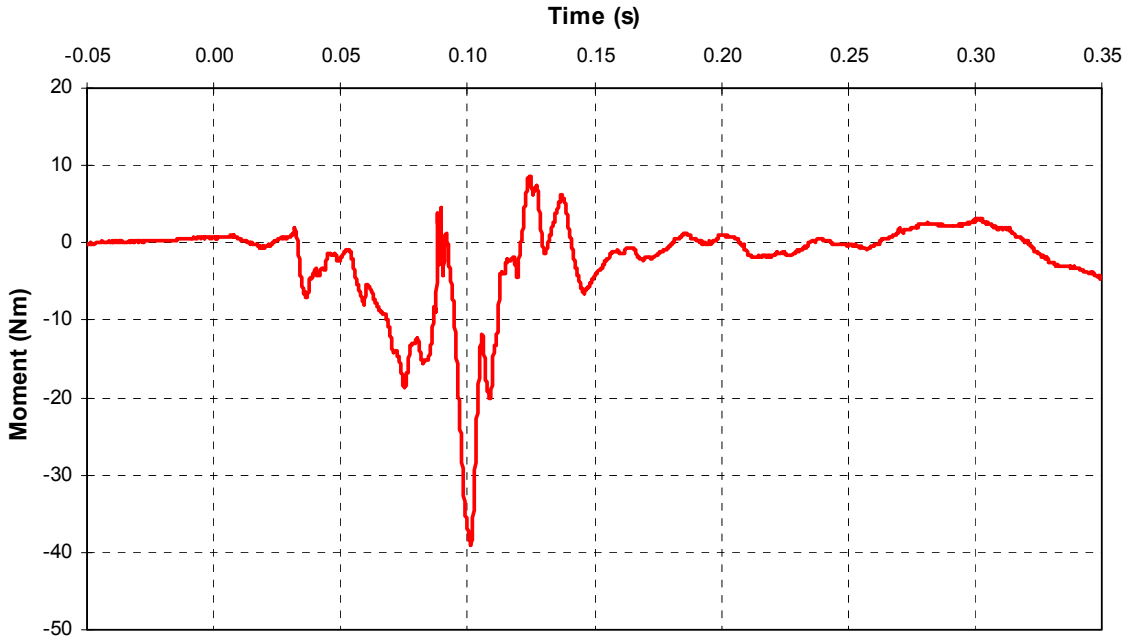
A- 41 CEF0313 2003 Lincoln Town Car Right Upper Tibia Vector Resultant Moment



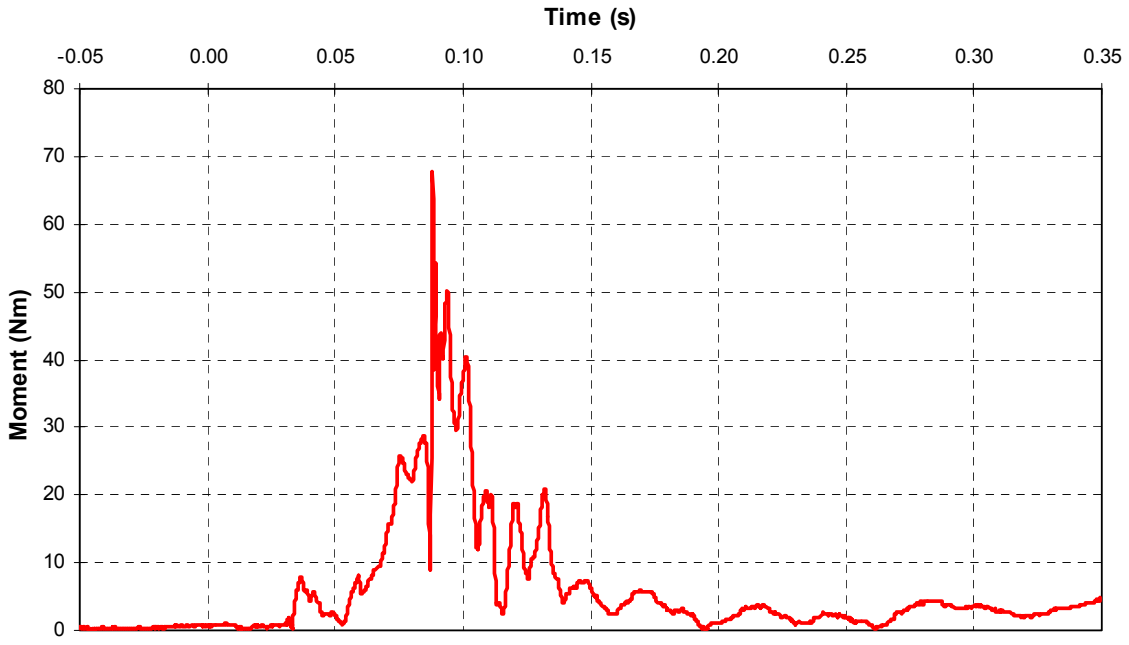
A- 42 CEF0313 2003 Lincoln Town Car Right Lower Tibia L-M Moment



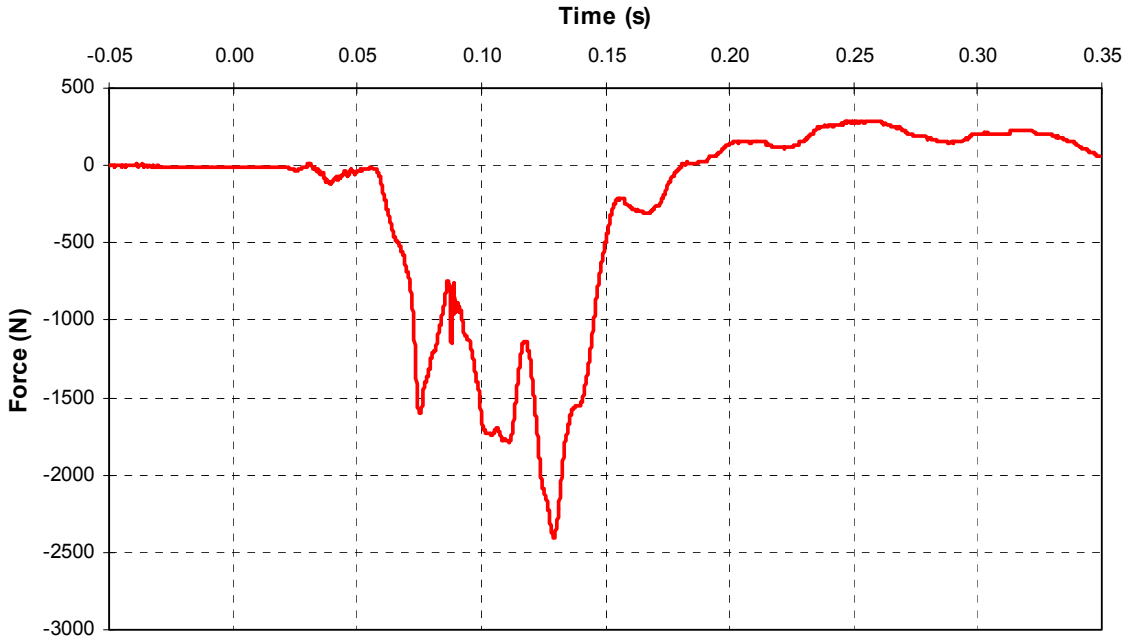
A- 43 CEF0313 2003 Lincoln Town Car Right Lower Tibia A-P Moment



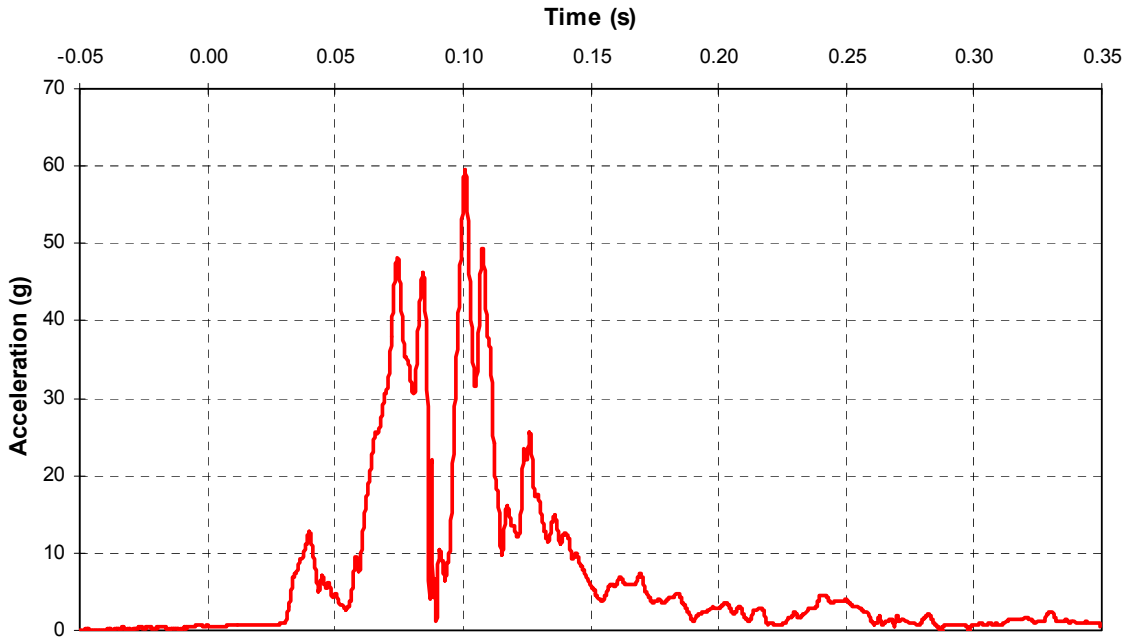
A- 44 CEF0313 2003 Lincoln Town Car Right Lower Tibia Vector Resultant Moment



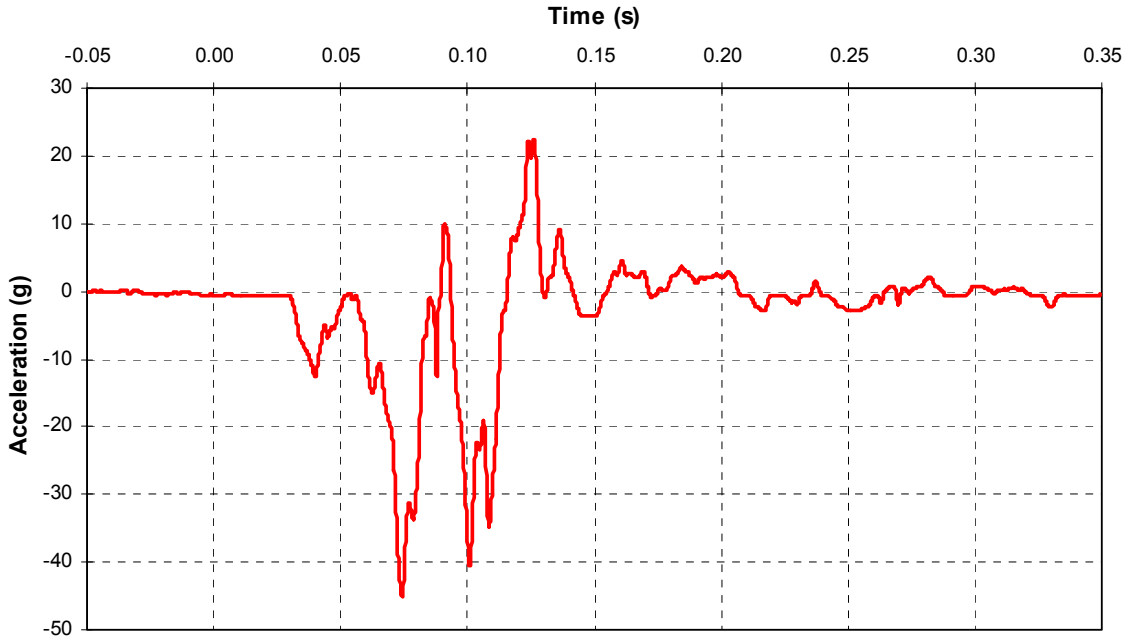
A- 45 CEF0313 2003 Lincoln Town Car Right Lower Tibia Axial Force



A- 46 CEF0313 2003 Lincoln Town Car Right Foot Vector Resultant Acceleration



A- 47 CEF0313 2003 Lincoln Town Car Right Foot A-P Acceleration



A- 48 CEF0313 2003 Lincoln Town Car Right Foot I-S Acceleration