FINAL REPORT – VIA Test Labs, Inc.

Prepared for

LAP BELT CINCH Inc.

Prepared by
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Testing Dates: 11 December 2002 – 19 December 2002

Testing of the Lap Belt Cinch Driver Enhancement Device

Test dates: Dec 11-19, 2002

Introduction

A test series was conducted in order to determine the effect of the Lap Belt Cinch driver enhancement device on the safety performance of a standard restraint system. All tests were identical A-B pairs except for the test variable (the presence or absence of the Lap Belt Cinch). The test series matrix utilized the driver side seating package of a popular midsize car. The rear seating package for this same car was used to assess performance differences between the standard seat belt system and a standard system fitted with the Lap Belt Cinch driver enhancement device. Child seats were utilized in the rear passenger seating compartment to assess whether an identifiable difference in performance could be determined.

A sled pulse was derived from publicly available 35 MPH Front Crash NCAP data downloaded from the NHTSA website. In order to provide more generic results several curves were studied to assess severity in terms of rise times and general pulse width for mid-size cars. A sled pulse was then derived and used to assess the performance of the standard system compared to one utilizing the Lap Belt Cinch driver enhancement product. One of the main focuses was to develop a generic pulse, which would generate significant belt loads, was broadly applicable to a wide range of vehicles by inference, and which could be utilized for A-B comparison purposes.

Test Matrix

In order to provide a direct comparison between a standard seat belt system with the Lap Belt Cinch driver enhancer and without the driver enhancer device, two rigidized left hand configuration front seating

Test Matrix (cont'd)

system environments were designed and fabricated based on the 1999 DN101 Taurus. The two seating systems were sled tested in a side-by-side study. Both manual and power seating systems were used for the 35 mph NCAP simulation testing which were placed in the mid-seating position with the adjustable 'D' ring height simulated at mid-position on a rigidized 'B' pillar structure. To simulate the adjustable 'D' ring, the height was adjusted for 50th percentile dummies by adding a shim to raise the simulated rigidized 'B' pillar to achieve the proper relationship of driver to 'B' pillar.

In order to assess the repeatability of each configuration, each test condition was replicated 3 times with 50th percentile dummies. The tests were paired initially, the sequence performed as follows: First a high speed NCAP test simulation (manual seat), then a low speed test (manual seat) followed by a high speed NCAP (manual seat) then two more low speed tests (power seat) and finally another high speed NCAP (power seat). The third high speed NCAP simulation was performed utilizing a power seat, while the second and third low speed runs utilized a power seat. The power seat appears to be stiffer than the manual seat and one of the test objectives was to determine any interactive effects relating to structural stiffness that might generate performance differences between a Lap Belt Cinch assisted standard restraint system and the standard restraint system.

- The lower speed pulse provided a maximum sled pulse of 9 g's and was executed at 20 mph to determine kinematic effects on the 50th percentile dummies at lower speeds, including pelvis movement relative to the seat system. Pelvis movement was measured by the attachment of a string pot.

- The NCAP derived pulse providing a maximum of 31 g's was executed at 35 mph to determine the effect on potential injury values and to note any issues with Lap Belt Cinch structural integrity, which could influence the safety performance of the standard seat belt restraint system.

Test Matrix (cont'd)

The front seats were then rotated 90 degrees to examine the effects of lateral loading on the Lap Belt Cinch driver enhancement device at 20mph. The power seats used in the last 35 MPH NCAP frontal simulation were utilized after being adjusted slightly to bring them to design position. It was felt that the stiffer seat would provide more observable differences between the Lap Belt Cinch assisted standard belt system and the standard belt system.

Two tests were conducted utilizing the rear seating environment of the chosen mid-size vehicle with child seats belted in with the standard restraint system and with the standard restraint system assisted by the Lap Belt Cinch device. Fifty-pound bags of shot were belted into the child seats utilizing the seat's 5-point restraint device.

A typical forward facing child seat was selected to evaluate any effects of the Lap Belt Cinch device on standard seat belt retention performance as well as evaluate any ease of use and performance enhancement effects if present. The specifics for this seat may be found in Appendix A

A side-by-side test was then conducted utilizing the simulated 35 mph NCAP crash pulse. To remove any right-left attachment bias two tests were run. One test utilized the Lap Belt Cinch device on the left side. The other utilized the Lap Belt Cinch device on the right side.

Targets were positioned on the child seats to assess seat kinematics with and without the Lap Belt Cinch device. The seat belt torso and lap loads were monitored as well to determine any attachment and restraint effects. One of the objectives of this study was to provide usage data revealing ease of use versus performance capability. For this reason the Lap Belt Cinch device was required to be tightened on both the left and right sides of the rear passenger compartment as if the operator was outside of the vehicle leaning in. The lap belt load developed was then subjectively evaluated for consistency right to left.

Test Environment

The left front seating environment was derived from a Taurus Vehicle. A fixture was designed which accommodated two left seating geometries to compare systems under identical front crash pulse and test conditions. The fixture simulates the attachment points in relation to the seating system for the chosen Taurus mid-size vehicle geometry.

To eliminate variability introduced by the body structure all restraint points were rigidized in accordance with industry practice for development test bucks. While front seat height adjuster locations were simulated, the actual height adjuster was not used. Instead the mid-height setting was used for 50th percentile HIII dummy testing and the lowest height setting would be used for 5th percentile HIII testing if necessary. This technique eliminated any variability associated with both "B" pillar geometry and/or the height adjuster component itself. Shims would be used to achieve the correct height relationship to the seat and dummy thorax for the different size dummies where necessary.

Test set-up

Front Seating

As noted above a rigidized fixture was derived around the seating package environment of a 1999 DN101 Taurus for the left front seat. The two identical front left seating system environments were mounted to an aluminum bed plate which was affixed to the Via sled system to allow side by side comparison for all front seat results.

Rear Seating

A 1999 rear Taurus DN101 vehicle clip was obtained for the rear seating environment. A seat cushion and back were fitted to this structure after all restraint system attachment points were rigidized for repeated testing. This system was then mounted to the aluminum bedplate which was affixed to the Via sled system.

Components Tested

- Standard Restraint Test Components

  All standard restraint hardware was purchased from the service parts department of a local car dealer and fitted to the test fixtures. The specific service part numbers as well Lap Belt Cinch prototype details may be found in Appendix A.

- Seating Components

  Standard left front seating assemblies were derived from in-tact Taurus salvage vehicles of appropriate model years relating directly to the DN101 Taurus vehicle design. The DN101 vehicle design designation was carried through model 1999. Seats were selected for this series which exhibited similar construction both for seat design and seat track attachment. The rear seating components were also acquired from similar in-tact salvage vehicles.

Dummy Positioning

Dummies were positioned per FMVSS 208 standard positioning procedures. Specific values recorded for this series may be found in Appendix B. Dummy values for each sled test run were held within +/- 2MM of the values listed.

A list of dummy specific Instrumentation may be found in Appendix C.

Dummy Data

Significant plots of dummy data derived from the testing may be found in Appendix D.

The full set of data, including photographs and high-speed videos has been written to a CD and provided to the requester.

Lap Belt Cinch Positioning Loads

The Lap Belt Cinch dummy seat belt loads were judged to be set to approximately twice the standard lap belt positioning loads of 4 lbs for FMVSS 208. This load level was arrived at by having several trained lab personnel of appropriate size sit in the test seat and adjust the lap tension to a point that they felt would provide adequate additional vehicle control when positioning themselves in an actual vehicle. This load was then duplicated when restraining the dummy using an appropriate force measurement technique.

Due Care Modification of the Restraint System Tongue

In order to investigate the effects of more radical modifications of the tongue, the rear anti-roping slot was removed from the test tongues as purchased from the dealer for the 1999 Taurus vehicle and the Lap Belt Cinch product was fitted per the Lap Belt Cinch specifications to the remaining part of the tongue. For the 1999 Taurus this modification was performed for both front and rear seating environments. The modification served two functions: 1) It provided an indication of the effects of a more radical modification of the restraint system tongue and 2) Provided a simulation of the updated Taurus design which no longer utilizes the anti-roping slot.

Analysis and Discussion of Test Results

Simulated 35 mph NCAP Tests

Head Resultant Acceleration: The results of the NCAP testing has shown that occupants restrained with the Lap Belt Cinch product may experience a slightly higher head resultant acceleration than an occupant restrained with just a standard production seat belt restraint system. This increased acceleration level poses no adverse safety concerns. By further investigation of the test data, it is clear that the increase is caused by the decreased pelvic displacement that is seen when the occupant is restrained using the Lap Belt Cinch product.

Upper Neck Force “X” Measurements: Analysis of the test data from the Lap Belt Cinch product testing has shown that there is no significant difference in upper neck force “X” measurements between occupants restrained with the Lap Belt Cinch product vs. a production seat belt restraint system. Although the force levels are very similar, there is a decrease in the slope of the force “X” curve. This difference is a direct effect of the Lap Belt Cinch’s’ ability to restrain the pelvis of the occupant more effectively than a production seat belt restraint system.

Upper Neck Moment “Y” Measurements: NCAP test data provides an indication that with the Lap Belt Cinch product, the upper neck moment “Y” levels are slightly lower and that the rise and slope to maximum amplitude lags that of a production seat belt system.

Chest Resultant Accelerations: Differences in chest resultant accelerations between the occupants restrained with the Lap Belt Cinch product vs. those restrained with production seat belt system were insignificant. During some tests the acceleration levels of the occupant with the Lap Belt Cinch product were 1G to 3 G’s higher than that of the occupant restrained with the production seat belt system. This difference can be attributed to the increased ability of the Lap Belt Cinch product to reduce the overall pelvic excursion of the occupant.

Pelvic “X” Acceleration: The pelvic resultant accelerations of occupants restrained with the Lap Belt Cinch product show that the Lap Belt Cinch product has the ability to “catch” the occupant faster than a production seat belt system. This increase in restraint capability is the design intent of the product.

Pelvic Displacement: The pelvic displacement measurements of all tests with the Lap Belt Cinch product showed a significant reduction in pelvic travel when compared to occupants restrained with production seat belt systems. This reduction could possibly lead to a reduction in injury criterion values when the Lap Belt Cinch product is integrated with current vehicle safety systems. Further testing will need to be conducted to validate this idea.

Low Speed Test Results (20 mph)

The most significant effect of the Lap Belt Cinch device appeared in the pelvis string pot displacement. The true ability of the Lap Belt Cinch to improve the "responsive feel" of the vehicle to the driver by reducing pelvic movement under performance driving conditions is evident during analysis of low G test results. In all instances the Lap Belt Cinch provided a dramatic increase in pelvic restraint performance. No adverse safety concerns are present in any of the data collected during low speed testing. The most important deduction that can be inferred from the data is that the Lap Belt Cinch product should provide the occupant increased handling feedback from the vehicle while providing a more stable and consistent seating position under performance driving conditions.

Rear Seat Results

Child Seat Results: Data collected during these tests has shown that the Lap Belt Cinch product provides identical restraint capabilities to child car seats utilizing production seat belt systems during a 35 mph collision.

Conclusions:

An analysis of the data indicates that that the Lap Belt Cinch driver enhancement device does not negatively impact seat belt performance as tested in the 1999 Taurus configuration utilizing a derived generic pulse producing a peak impulse of 31 g's.

An overview of the test series and a results summary is provided in Appendix E.

Recommendation:

While this product is only designed and intended to enhance driver seating stability to improve driver control of the vehicle and occupant comfort, there seems to be a safety enhancement effect, which is

caused by the reduction of lap belt slack. As a result of this phenomenon, it is recommended that the Lap Belt Cinch driver enhancement device be examined as a device for possible improvement of occupant safety.

As currently configured and tested it is believed that any safety performance enhancements stem from the reduction of pelvis movement during a sled simulated crash event. Test data implies potential meaningful reductions may be possible in frontal impact submarining/IP knee contact and side impact hip contact.

Appendix A

Components Tested

Front Restraint Hardware

Standard hardware:

Left hand front retractor, belt and tongue assy. For 1999 Taurus :
Part No. XF1Z-54611B09-AAC

The standard buckle assembly is part of the seat assy.

Pretensioning retrofitted hardware:

Left hand front pretensioning retractor, belt and tongue assy. For 2001 4 dr. Focus:
Part No. FYS4Z-54611B09-DA

Left hand front buckle assy. For 2001 4 dr. Focus:
Part No. FYS4Z-6161203-HB

Rear Restraint Hardware

Retractor, belt and tongue assemblies:
LH - XF1Z-54611B69-AAB
RH - XF1Z-54611B68-AAB

Rear Buckle Assemblies:
LH - F7DZ-5460045-AAD (Single buckle)
RH - F8DZ-5460044-AAA (Double buckle)

Lap Belt Cinch: Prototype level October 30, 2002

Child Seat

Evenflo Express™ Style 3181357 Forward facing Child/Booster Seat. Purchased from Target Stores of Brighton, MI.

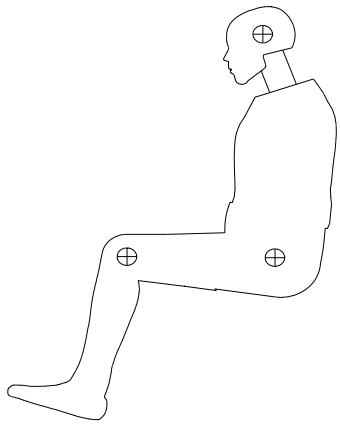
Appendix B

Dummy Positioning Data

Dummies were positioned per FMVSS 208 standard positioning procedures. Specific values recorded for this series are listed below. Dummy values for each sled test run were held within +/- 2MM of the values listed.

ATD PC

LAP BELT CINCH INC.



HEAD
X= 1065 mm
Z= 964 mm

KNEE
X= 533 mm
Z= 420 mm

H-POINT
X= 966 mm
Z= 311 mm

Pelvic Angle: 22.5 degrees
Knee Spacing: 203 mm
Seat Back Angle: 15 degrees measured at head rest
Ankle Spacing: 203 mm
Foot - Tibia Angle: 90 degrees

All measurement are from sled bed plate forward for X, and from sled

Appendix C

Instrumentation

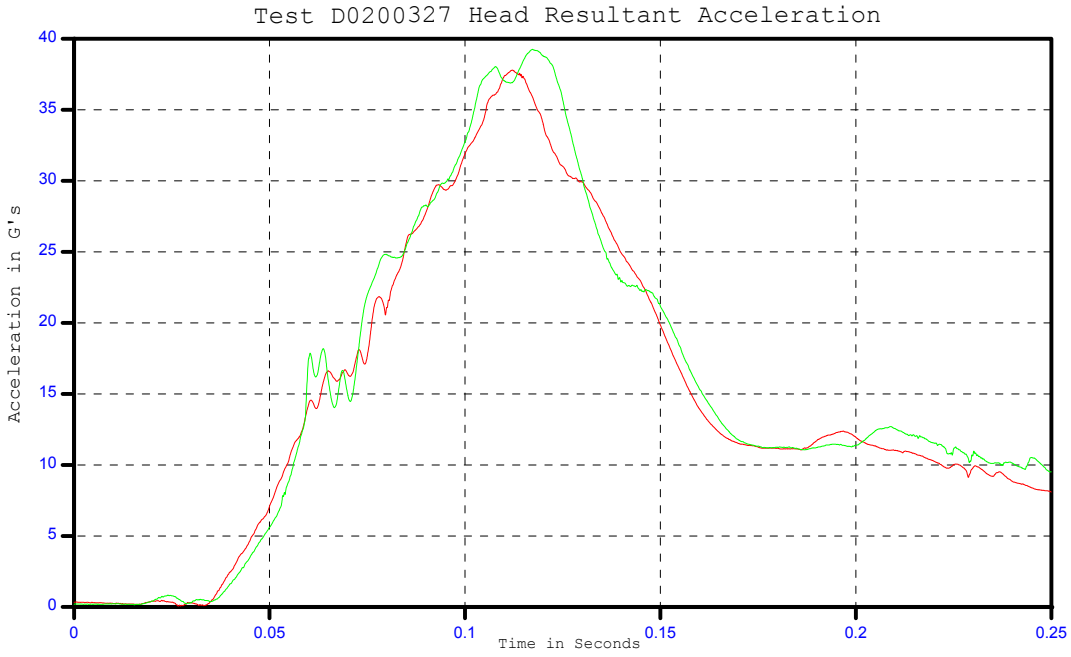
Hybrid III 50%th ATD's:

Head "X" accelerometer
Head "Y" accelerometer
Head "Z" accelerometer
Upper neck force "X" load cell
Upper neck force "Y" load cell
Upper neck force "Z" load cell
Chest "X" accelerometer
Chest "Y" accelerometer
Chest "Z" accelerometer
Chest deflection transducer
Pelvic "X" accelerometer
Pelvic "Y" accelerometer
Pelvic "Z" accelerometer
Pelvic string pot to measure excursion
Seat belt load cell

Appendix D

Significant plots of dummy data

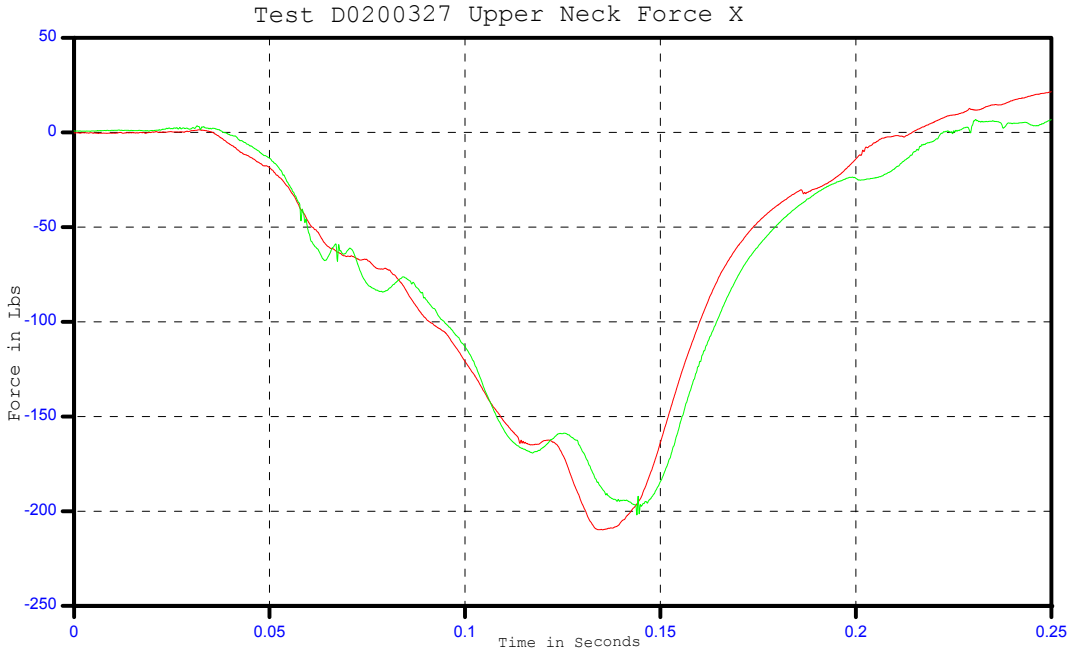
Lap Belt Cinch Inc. NCAP Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Head Resultant Accelerations NCAP Pulse

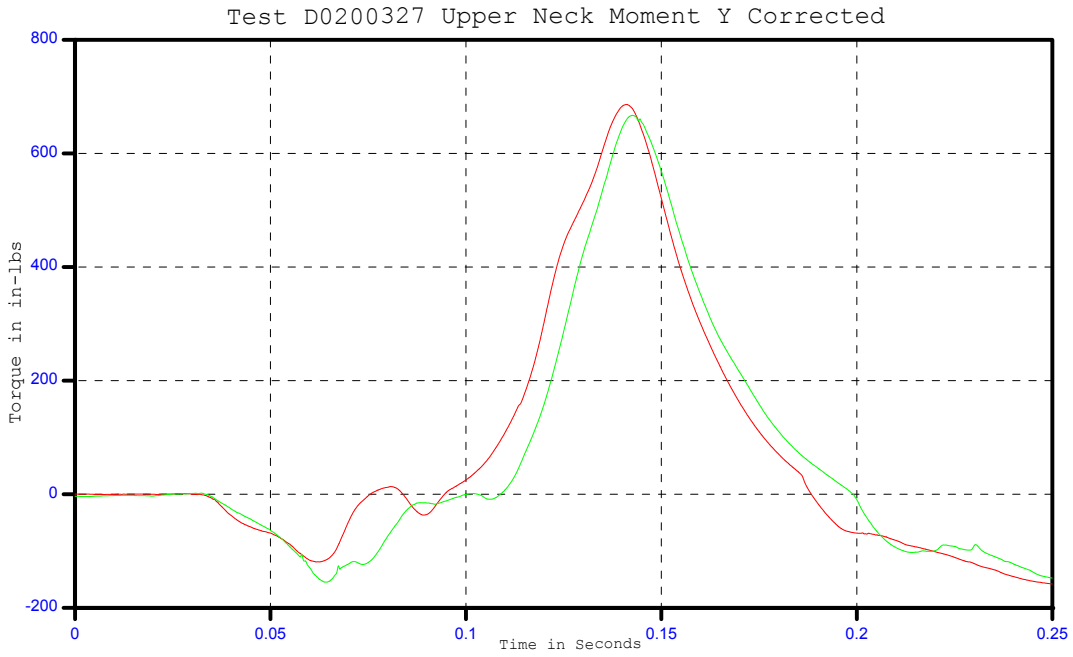
Lap Belt Cinch Inc. NCAP Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Upper Neck Force “X” NCAP Pulse

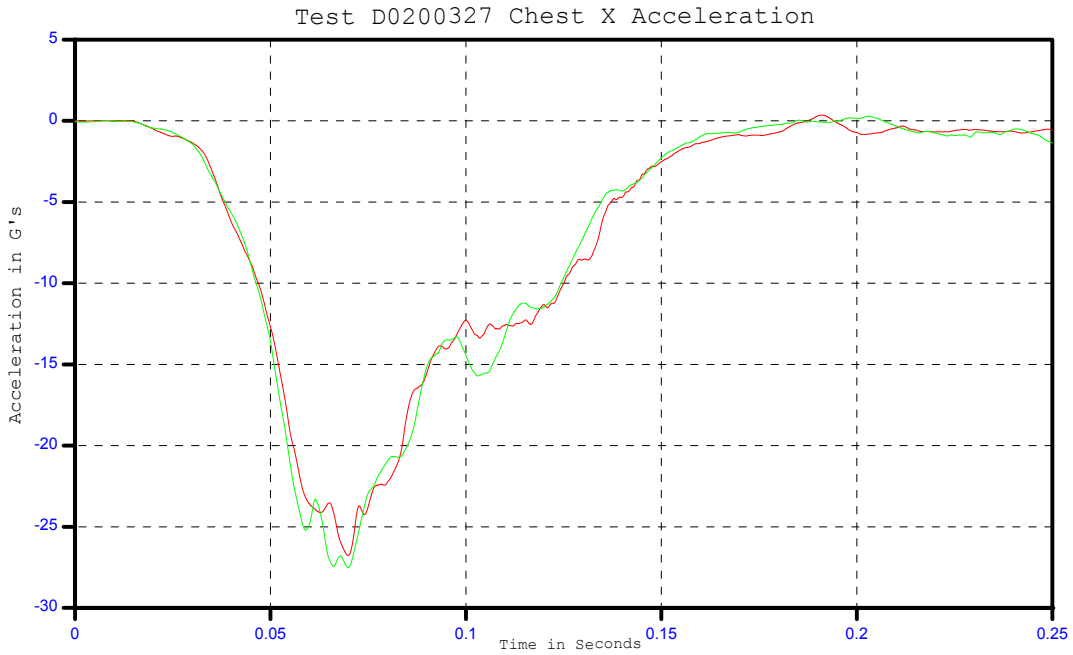
Lap Belt Cinch Inc. NCAP Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Upper Neck “MY” Corrected NCAP Pulse

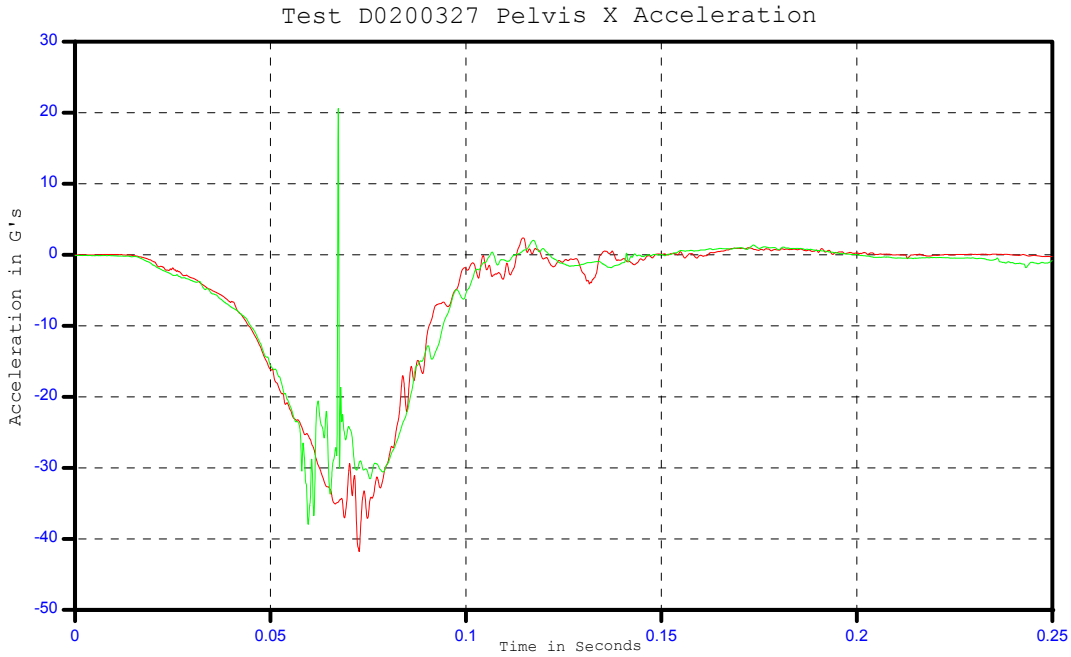
Lap Belt Cinch Inc. NCAP Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Chest Resultant Acceleration NCAP Pulse

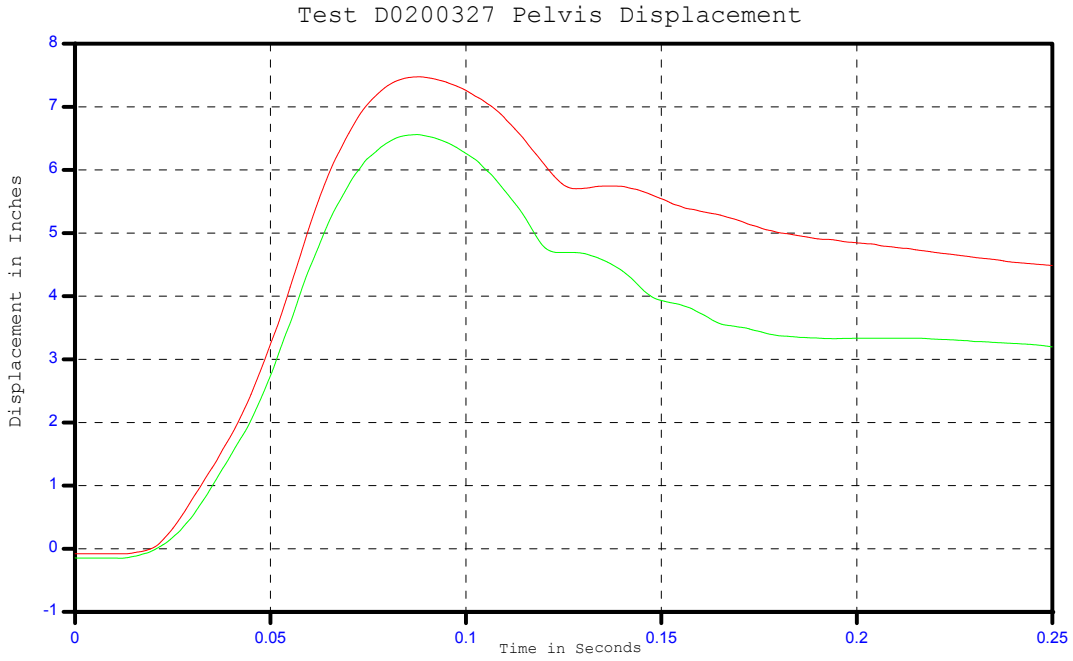
Lap Belt Cinch Inc. NCAP Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Pelvic “X” Acceleration NCAP Pulse

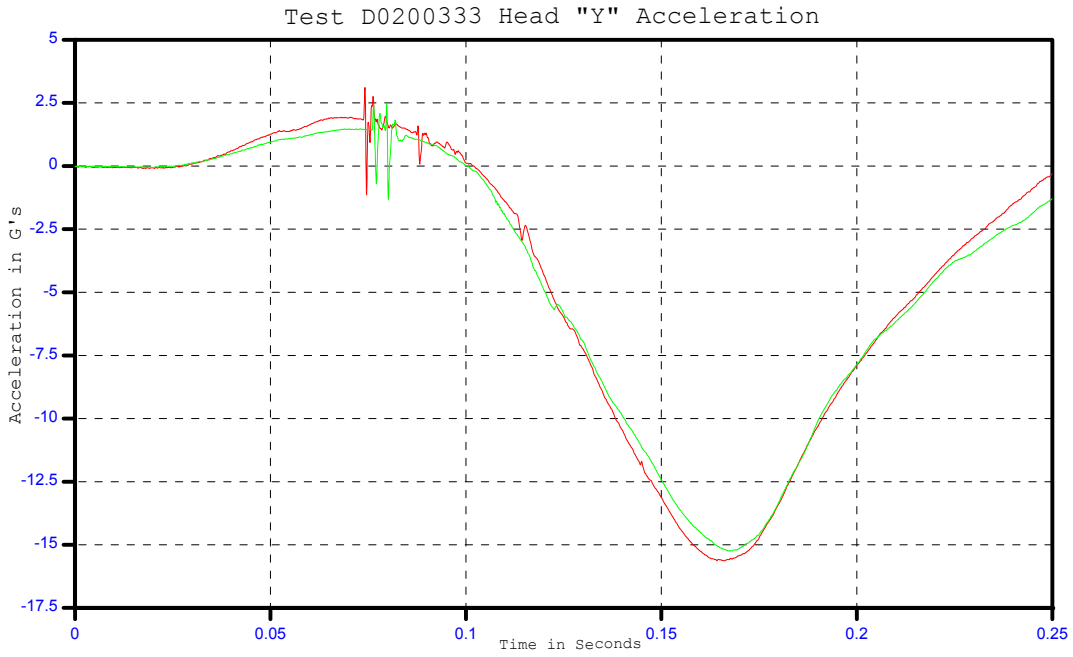
Lap Belt Cinch Inc. NCAP Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Pelvic Displacement NCAP Pulse

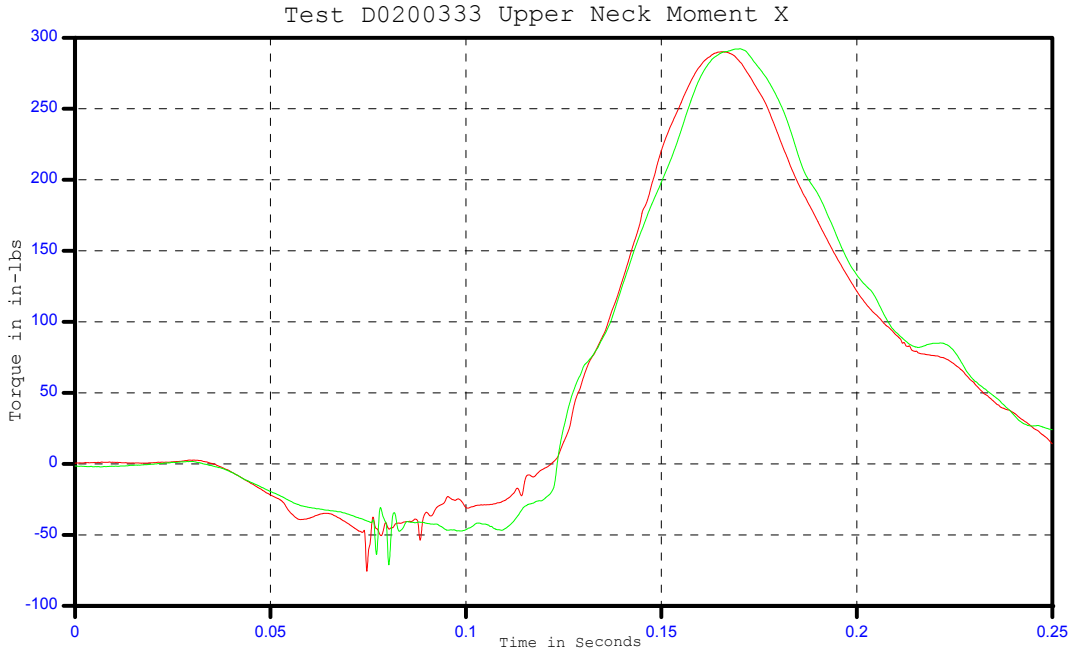
Lap Belt Cinch Inc. Low G Lateral Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Head “Y” Acceleration Low G Lateral Pulse

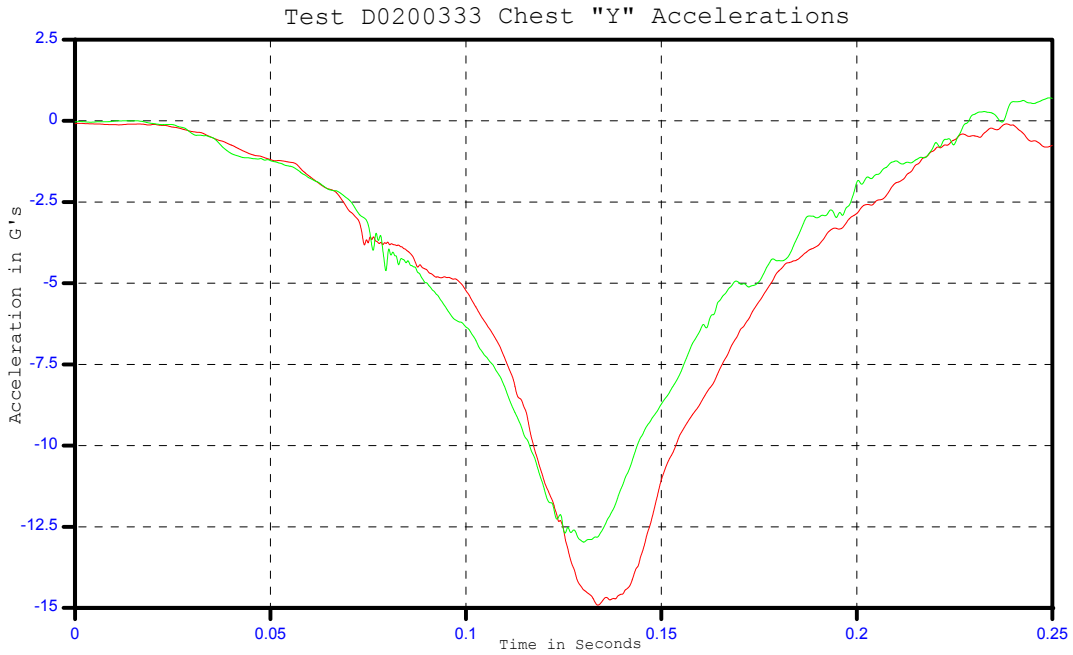
Lap Belt Cinch Inc. Low G Lateral Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Upper Neck Moment X Low G Lateral Pulse

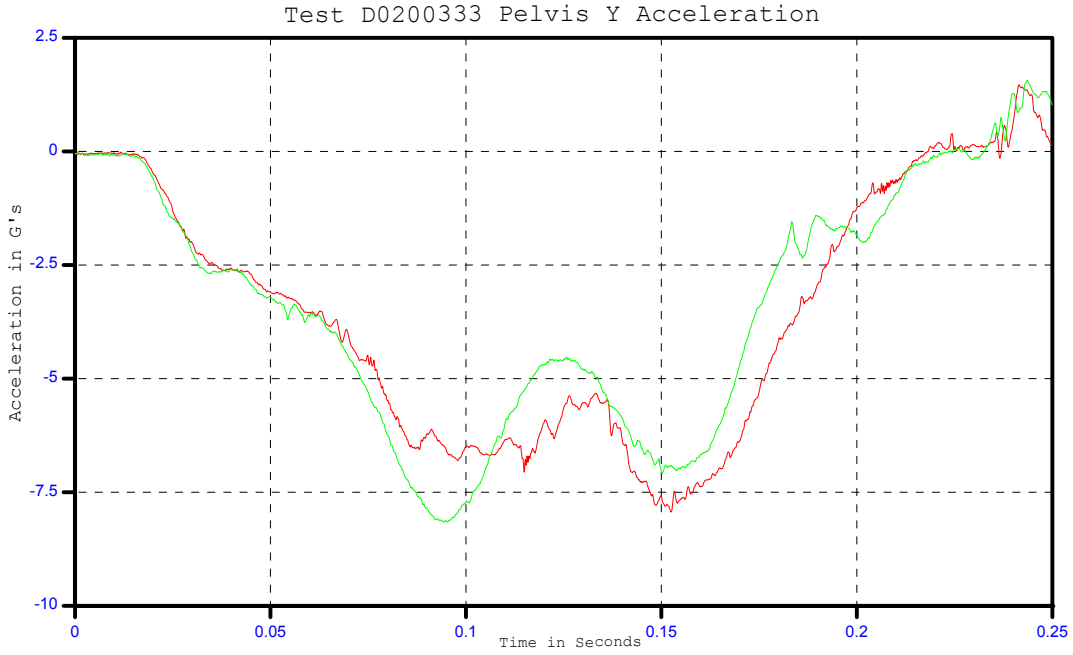
Lap Belt Cinch Inc. Low G Lateral Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Chest “Y” Acceleration Low G Lateral Pulse

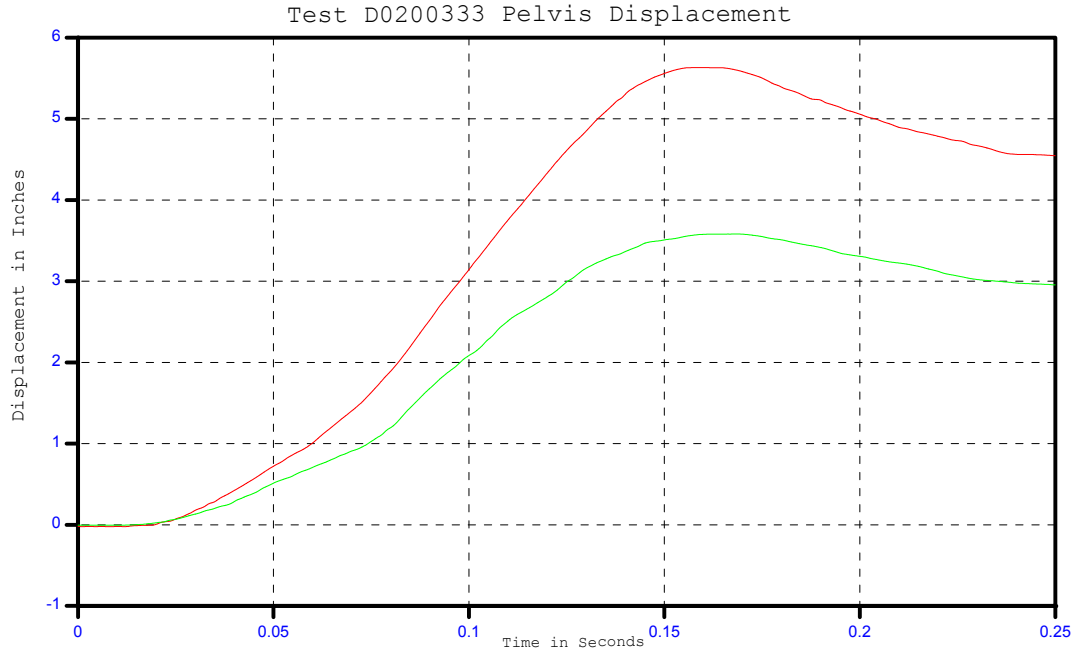
Lap Belt Cinch Inc. Low G Lateral Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Pelvis “Y” Acceleration Low G Lateral Pulse

Lap Belt Cinch Inc. Low G Lateral Sled Pulse -- VIA Test Labs Inc.



Red = Test Production Seat Belt Green = Lap Belt Cinch

Pelvis Displacement Low G Lateral Pulse

Appendix E

OVERVIEW and SUMMARY OF THE TEST SERIES MATRIX

Performed At: VIA TEST LABORATORIES, INC
December 11-19, 2002

	Test Description	Test Design	Number Of Tests	Preliminary Conclusions[1]
Driving Related	Low Speed Frontal sled 20 mph; 9 g peak Standard front seats and seat belts Instrumented ATDs[5]	A-B Test[2] ATD used in pairs Identical test conditions[4]	3[3]	All key measured parameters were the same or better for the Lap Belt Cinch; no negative impact on safety
	High Speed Frontal sled NCAP sled pulse (FMVSS 208) 35 mph; 31 g peak Standard front seats and seat belts Instrumented ATDs	A-B Test ATD used in pairs Identical test conditions	3[6]	All key measured parameters were the same or better for the Lap Belt Cinch; no negative impact on safety
	High Speed Frontal sled NCAP sled pulse (FMVSS 208) 35 mph; 31 g peak Standard front seats Pyrotechnic retractors used	A-B Test ATD used in pairs Identical test conditions	1	All key measured parameters were the same or better for the Lap Belt Cinch; no negative impact on safety
	Low Speed Lateral sled 20 mph; 9 g peak Standard front seats and seat belts Instrumented ATDs	A-B Test ATD used in pairs Identical test conditions	1	All key measured parameters were the same or better for the Lap Belt Cinch; no negative impact on safety
Child Seat	High Speed Frontal sled NCAP sled pulse (FMVSS 208) 35 mph; 31 g peak Standard rear seats and seat belts EvenFlo Child Safety Seats	A-B Test Child seats used in pairs[7] Identical test conditions 50 pound ballast in seats	2	All key measured parameters were the same or better for the Lap Belt Cinch; no negative impact on safety

[1] Validation of conclusions may require additional testing
[2] One control plus one variable; all conditions as identical as possible except one restraint had the Lap Belt Cinch attached
[3] Identical replications (non-consecutive; see report)
[4] Each test was conducted with two ATDs on one sled run; the ONLY difference was one ATD has a Lap Belt Cinch on its seat belt
[5] ATD = Anthropomorphic Test Dummy
[6] The seats and seat belts were replaced after each high speed test
[7] The side the cinch was on was reversed for the second test