Maximum Acceleration in Reverse Gear to Simulate Unintended Acceleration Scenario

Posting Date: June 6-2015

A tragic fatal collision occurred at the Costco retail outlet in London, Ontario on July 25, 2014 in which two children were killed when a 2004 Chevrolet Monte Carlo reversed on the store's parking lot, at full speed, and drove through the front doors of the store. The driver of the vehicle was later charged with criminal offences even though she claimed that her foot became stuck underneath the brake pedal.

Figure 1: View of the entrance to the Costco retail store on Wellington Road in London, Ontario on July 24, 2014. Police tape surround the front doors where a red, 2004 Chevrolet Monte Carlo reversed at high speed killing two family members.

Testimony provided by investigating police indicated that data was obtained from the Monte Carlo's event data recorder ("Black Box").

The public was informed that at 5 seconds before impact the vehicle was travelling at 11 km/h, at 4 seconds 22 km/h, at 3 seconds 35 km/h, at 2 seconds 43 km/h and at 1 second 46 km/h. Police also stated that, at 5 seconds before the crash the throttle was a 100%, then 84 % at 3 seconds and at 100% again at 1 second before impact. There was also no evidence of braking over the full 8 seconds of available pre-crash data.

Figure 2: View showing the direction from which the Monte Carlo reversed on its way toward the Costco front doors in the background. This photo was taken a few days after the incident.

To test these findings Gorski Consulting conducted a maximum acceleration test in reverse gear using a vehicle with a similar engine (3.8 litre) and our findings are presented in this article.

Figures 1 through 5 show the test vehicle, a 2007 Buick Allure, positioned on the test site, as well as during the maximum acceleration test. Four traffic cones were placed along the left side of the test vehicle at 2-metre gaps. The first cone was placed next to the centre of the left front wheel. After accelerating through the position of the cones the vehicle was braked, hard, until it came to a stop. During this test the accelerometer and gyros of an iPhone 4S documented the vehicle's acceleration and motion. This data was sent via e-mail to a host computer and transferred to an Excel spreadsheet where it was analysed.

Video and still photos were taken of the road surface in the area where the vehicle was accelerated and braked. Close examination of the road surface made it possible to detect faint acceleration marks as well as more prominent ABS braking marks on the surface. Figures 6 through 9 show this area shortly after the test was completed. No attempt was made to select an area of the road where the tire marks might be more visible and this provides an opportunity to consider the real life situation where an acceleration might occur in less than ideal locations,where the presence of other tire marks, debris or other unrelated markings might mask the presence of the relevant evidence.

Figure 3: View of 2007 Buick Allure test vehicle at its position before the acceleration test.

Figure 4: Left-side view of the test vehicle at its position before the acceleration test.

Figure 5: View after the test vehicle has reversed 2 metres during the test.

Figure 6: View after the test vehicle has reversed 4 metres during the test.

Figure 7: View after the test vehicle has reversed 6 metres during the test.

The first visible indication of a tire "patch" indicating that the ABS system was engaged was at 16 metres from the starting location of the acceleration. In reality there was evidence of a tire mark prior to that location however it would be unclear whether that mark was from acceleration or braking due to the lack of any detail in the faint mark. The vehicle came to a halt 19.5 metres from its starting location.

Figure 10 is a chart of the longitudinal and lateral accelerations experienced by the test vehicle during the test. It shows maximum, positive, longitudinal acceleration for a period of 43.1 to 45.1 seconds. This positive acceleration reached a maximum of about 0.47 g and then reduced slightly to about 0.35 g after 2.0 seconds at about 45.1 seconds.

From about 45.1 seconds we see the transition where the driver releases the accelerator pedal and applies the brake pedal. This transition occurs for a period of about 1.0 second at which point the maximum level of braking (negative acceleration) is reached at about 0.65 g. The longitudinal acceleration then drops as the vehicle comes to a halt at about 47.5 seconds. There is some noise visible in the lateral acceleration data during the time that the vehicle is being braked to a halt.

Figure 11 is a chart showing the change in the longitudinal and lateral angle of the test vehicle during the throttle application and braking.

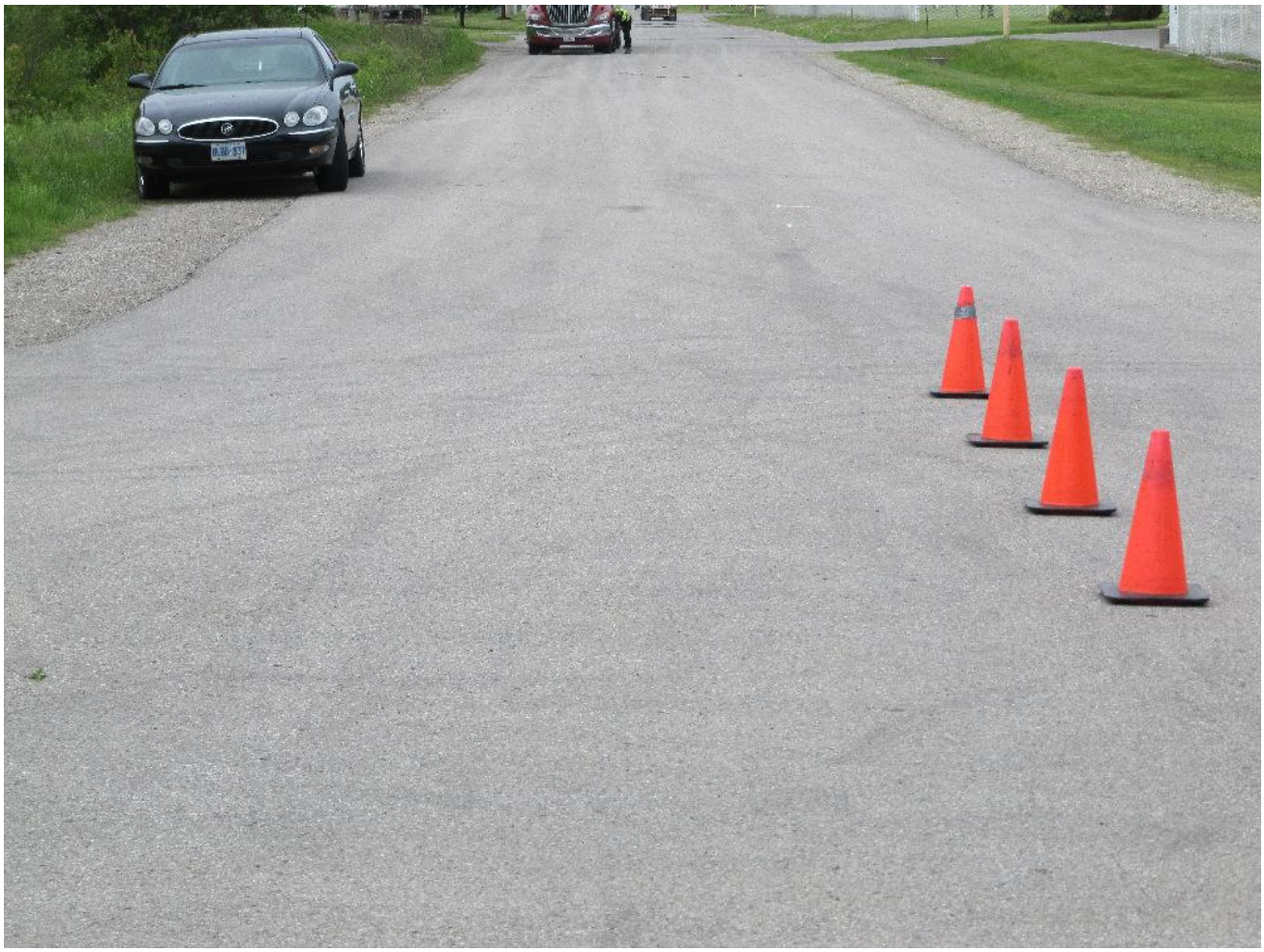

Figure 8: View of the road surface in the area where the test was conducted.

The chart expressing the angle of the vehicle is in terms of radians. One radian is equal to 57.3 degrees. Thus, as expected, at the commencement of the acceleration the front end of the vehicle dove down while the rear end lifted. This reached a maximum of about 20 degrees at about 1.8 seconds after the start of the acceleration. This was followed by a rapid change in the vehicle's orientation in the opposite direction as the vehicle was braked. Thus the front end began to lift while the rear end dropped reaching a maximum of approximately 16 degrees at the instant where the vehicle came to a halt about 4.3 seconds after the start of the acceleration.

As can be seen in Figure 11, the lateral orientation of the vehicle did not change significantly during the test.

Thus this test demonstrated the rapid increase in speed that would occur if a vehicle experienced full-throttle acceleration. It demonstrates that a vehicle equipped with a similar engine to the 2004 Chevrolet Monte Carlo, would experience a rearward acceleration that would reach a peak of about 0.47 g at about 0.4 seconds after the commencement of the acceleration with a gradual reduction in that rate to about 0.35 g at 2.0 seconds after that commencement.

Figure 9: View of the road surface where the test was conducted.

Figure 10: View of the road surface where the test was conducted.

Figure 11: View of the road surface where the test was conducted.

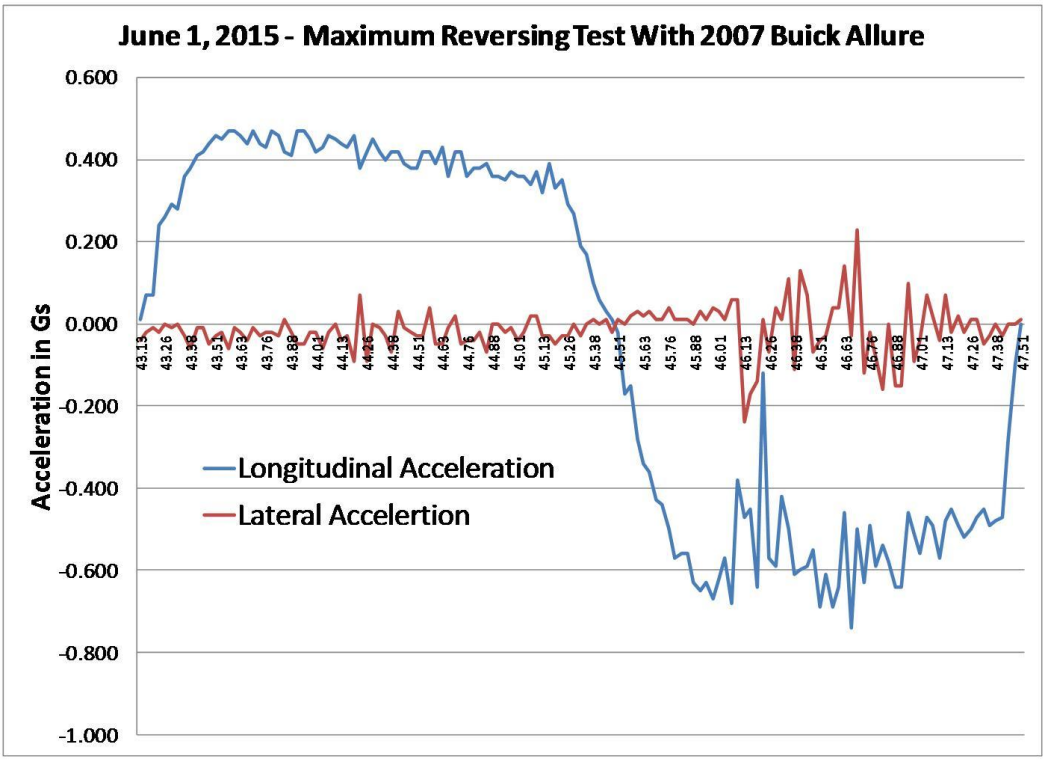

Figure 12: Chart of the longitudinal and lateral acceleration of the test vehicle during its positive acceleration (full throttle application) and negative acceleration (braking).

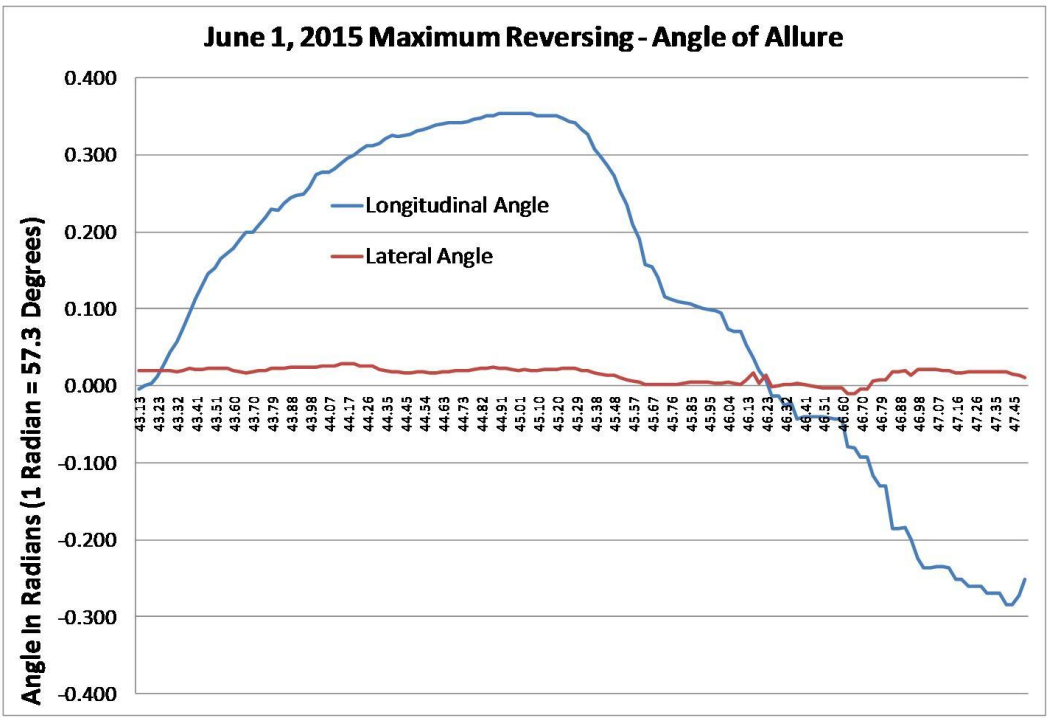

Figure 13: Chart showing the change in the longitudinal and lateral angle of the vehicle (sprung mass) during the maximum throttle and brake applications.

The brakes were applied about 2.0 seconds after the commencement of the acceleration and this resulted in the deceleration reaching a maximum of about 0.65 g for this particular surface. This rate of deceleration is rather low for an ABS equipped vehicle on an asphalt surface. However the test was performed at the dead end of a roadway (Cheapside Street, London, Ontario) which would not experience any regular traffic. Thus deposits of dust and dirt would be expected to degrade the surface's ability to generate a higher deceleration.

Such high rates of acceleration can create a situation where the driver might have difficulty controlling the direction of the vehicle's travel. There would be an extreme transfer of weight initially onto the front wheels and then to the back wheels with a very sudden transition between the two. Such transfers would affect the tire force such that minor changes in the orientation of the vehicle could be quickly magnified at a time when the driver's primary attention might be with respect to reducing the acceleration. Alternatively, if the acceleration is taking place in a tight space, which is common in parking lots, the driver may also have to deal with avoiding impacts with other vehicles and pedestrians and thus diverting one's full attention away from strategies to reduce the unintended acceleration.

With respect to the collision at the London Costco store, the news reports of the criminal trial failed to inform the public about crucial matters of concern. For example, if the Monte Carlo was being reversed near 100% of its capacity, why did the vehicle's speed increase by only 3 km/h between 2 and 1 seconds before impact. This failure to follow the trend of rapid acceleration cannot be explained by any braking force as the police expert stated that the event data showed that the brakes were not applied for the full 8 seconds before impact. Secondly there was no discussion of any tire marks being present and what those tire marks might indicate.

Finally there was no expert testimony provided at trial except for the evidence of the police expert who reportedly had only four years of collision experience and had never conducted an investigation involving an unintended acceleration. In an important case like this involving the death of two innocent children the court and public need to be guided with accurate interpretations of the evidence and that guidance cannot come from lay witnesses or inexperienced investigators.

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