Maximum Braking On Snow-Covered Asphalt Roads - Tests From February 25, 2012

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A fatal collision occurred on the morning February 25, 2012 on Oxford County Road 6 just north of Embro, Ontario Canada. It was reported that a snow squall had passed through the site at the time of the collision and police reported that the road conditions might have been a factor in the crash.

Coincidentally we had commenced some braking testing on the morning of February 25th, 2012 and we happened to travel onto Oxford County Road 6 later on that morning, but after the collision had occurred. This coincidence allows for analysis of the type of conditions that the deceased northbound driver might have experienced just prior to the collision.

Before presenting our test results we want to describe the collision event.

A 2004 Chevrolet Avalanche was travelling northbound on Oxford County Road 6. The driver, a 38-year-old male, was returning hom e from a hockey game in Embro, Ontario and was accompanied by his six-year-old son. At the same time, a large tanker truck, loaded with an agricultural feed product, was travelling southbound on the same roadway. It was determined that the driver of the Avalanche likely lost directional control of his vehicle and the Avalanche travelled across the centre-line and into the path of the tanker truck. The collision resulted in fatal injuries to both the father and son.

Photos on the following page show the general accident characteristics from the north looking south (top photo) and from the south looking north (bottom photo). These photographs were taken the day after the collision.

A photograph was available, taken by news media on the day of the collision, while the two vehicles were still at their final rest positions. This photograph was taken from the south looking north, similar to the view shown in the bottom photograph shown on the following page. The news photograph showed an obvious area of snow that had blown onto the road just south of the area of impact between the vehicles. However the rest of the road surface remained bare and dry. The character of the snow drift indicated that it had blown onto the road from the west to the east and that the majority of the snow was located in the southbound lane. There was only partial snow-cover in the northbound lane where the Avalanche was travelling. From that finding one would find it curious that the driver of the Avalanche would lose control of the vehicle since his lane was not in the worst condition since there was likely more snow in the southbound lane. We will discuss this issue further after we have reported the findings from our braking tests.

Results of Brake Testing on February 25, 2012

Instrumentation of our test vehicle was identical to the set-up described in our previous website article uploaded on February 10, 2012 entitled "When, Where and Why Roads Become Slippery - Some Objective Testing By Gorski Consulting".

The testing was straightforward: We drove our vehicle along various roadways and selected a location where there we no other vehicles or any roadside obstacles. We then applied our brakes to their maximum until our test vehicle came to rest. The video cameras documented the deceleration our test vehicle. We inserted the videos from all four cameras into an Adobe Premiere project such that the view of all four cameras was synchronized with respect to time. We then determined when our brakes were applied by noted when the rear brake light became illuminated. We then tracked the progress of our vehicle until it came as stop. This data resulted in calculations in the attached excel spreadsheet. (below).

The variable that enables us to compare one road surface to another is the "Deceleration Rate (g)" noted in the last column of the spreadsheet. The value in this column tells us how slippery the surface is because it tells us the rate at which our vehicle is slowed down as the vehicle slides toward its stop. A low value indicates that the road surface is slippery. For example, if our test vehicle was sliding on ice the Deceleration Rate would likely be near 0.05 or 0.10. You can note that in many of our tests where we braked over a snow-covered surface the Deceleration Rate was in the range of 0.180 to 0.220.

However where the vehicle was braked over surfaces where there was partial exposure to the bare pavement the Deceleration Rate rose dramatically. For example, in Test 3 we braked on a surface that was almost bare pavement that was also wet and the Deceleration Rate was 0.600.

The values for stopping distance and time to stop are also reveal the differing ability of a vehicle to stop from a similar speed. In Test 3 we were able to come to a stop in about 3 seconds and distance of about 28 metres from an initial speed of about 60 km/h. Yet on a more slippery surface such as in Test 21 our vehicle took over 12 seconds and 126 metres to stop.

In Test 14, we braked over a snow-covered surface but near the end of the motion the right side wheels of our vehicle travelled onto some bare pavement. The higher Deceleration Rate from the bare pavement caused our vehicle to rotate clockwise. Although there is nothing mysterious about this occurrence it is an important observation when we consider what might happen to a vehicle when a driver encounters a snow drift that does not cover the full width of the road or may only cover a portion of the travel lane. If a driver brakes and only one side of the vehicle's tires encounter a snow drift while the other side encounters relatively bare pavement, there can be a substantial difference in the tire force on one side of the vehicle's centre-ofgravity versus another and this can destabilize the vehicle. And this brings us back to our review of the fatal accident we mentioned at the beginning of this article.

Maximum Braking Test Date: February 25, 2012 ; Test Vehicle 2007 Buick Allure

Test #	Road Description	Snow Description	Test Speed (km/h)	Braking Time (Seconds)	Braking Distance (Estimated)	Deceleration Rate (g)
1	Wilton Ave, WB, East of Highbury	Wet asphalt with thin layer of crushed and partly melted snow, Temp = -1 cel	35	5.87	28.54	0.169
2	Adelaide St, NB, North of Medway Rd	Snow-drift with thin layer of hard snow in both wheel tracks	60	9.4	78.31	0.181
3	Adelaide St, NB, North of Nine Mile Rd	Wet pavement in right wheel track, partially bare in left wheel track	65	3.07	27.72	0.600
4	Adelaide St, NB, North of Ilderton Rd	Thin layer of snow, approx 1" in both wheel tracks, Temp = -2 cel	58	7.67	61.89	0.214
5	Adelaide St, NB, North of Twelve Mile Rd	Thin layer of snow, approx 1" in both wheel tracks, Temp = -2 cel	60.5	8.27	69.62	0.207
6	Adelaide St, NB, North of Thirteen Mile Rd	Packed and loose snow in both wheel tracks, approx 1" depth	59	8.2	67.18	0.204
7	Adelaide St, NB, North of Thirteen Mile Rd	Drifted snow; more in middle of road (@2 inches) than in right wheel track (@1 inch)	70	10.47	102.07	0.189
8	Perth Rd 138, EB, West of Perth Rd 163	Drifted, loose and packed snow, approx 1 inch deep	64	8.53	76.07	0.212
9	Mothwell Rd, EB, West of Thames River	Thin layer of crunchy, hard, blown snow, approx 1 inch deep, Temp = -2 Cel	58	8.87	71.59	0.185

Test #	Road Description	Snow Description	Test Speed (km/h)	Braking Time (Seconds)	Braking Distance (Estimated)	Deceleration Rate (g)
10	Mothwell Rd, EB, East of Thames River	Complex surface conditions: wet snow, some dry brittle snow, some small bare patches of wet pavement; Temp = -1 cel	61	8.73	73.99	0.198
11	Perth Rd 140, NB, south of Perth Rd 20	Gravel surface containing thin layer of intermittent fronzen snow mixed with visible gravel; Temp -1 cel	49	3.97	27.09	0.349
12	Perth Rd 140, NB, south of Perth Rd 20	Gravel surface containing thin layer of intermittent fronzen snow mixed with visible gravel, slightly more snow that Test 11; Temp -1 cel	51	4.53	32.10	0.319
13	Perth Rd 140, NB, just south of stop sign at Perth Rd 20	Gravel surface covered with crushed snow	58	5.87	47.30	0.280
14	Perth Rd 20, Travelling SE, South of Highway 7	Packed snow drift, near end of test vehicle slides onto bare pavement , particularly on right front tire which causes slight vehicle rotation	61	7.83	66.29	0.221
15	Perth Rd 20 Travelling SE, NW of Perth Rd 113 (or also known as Oxford Rd 6)	Hard packed snow drift, crunchy and rippled top appearance, snow approx 1 inch deep; Temp -1 cel	64	8.27	73.63	0.219
16	Perth Rd 20 Travelling SE, Approaching Perth Rd 113 (or also known as Oxford Rd 6)	Significant downgrade with crunchy and rippled, packed snow surface, approx 1" deep causing car to weave back and forth laterally during slide	50.5	12.87	90.45	0.111
17	Plover Mills Rd, WB, East of Oxford Cty Rd 119	Snow drift containing small patch of bare wet pavement; Temp -2 Cel	65	7.73	69.89	0.238

Test #	Road Description	Snow Description	Test Speed (km/h)	Braking Time (Seconds)	Braking Distance (Estimated)	Deceleration Rate (g)
18	Plover Mills Rd, WB, East of Cobble Hills Rd	Snow drift containing approx 2 inches of loose and packed snow; Temp = -2 Cel	70	10.93	106.58	0.181
19	Plover Mills Rd, WB, West of Cobble Hills Rd	Snow drift containing approx 2-3 inches of loose and packed snow; Temp = -2 Cel	70	11.23	109.61	0.176
20	Plover Mills Rd, WB, West of Cherry Hill Rd	Snow drift containing approx 2-3 inches of loose and packed snow; Temp = -2 Cel	70	9.93	96.46	0.200
21	Plover Mills Rd, WB, Just East of Nissouri Rd	Snow drift containing approx 2-3 inches of loose and packed snow; Temp = -2 Cel	75	12.07	125.83	0.176

Assessment of Possible Cause of Fatal Collision

In order to come to a conclusion about how the driver of the Avalanche might have lost control of his vehicle it would be necessary to examine all the available evidence including the damage to the vehicles, obtaining a download of any data available from the vehicle's event data recorder ("Black Box") and any observations made from witnesses or other drivers. We are not in a position to obtain this information therefore we can only comment on the possibilities that could be explored from our test results.

If the wind direction at the time of the collision was from west to east then a snow drift would have developed from the open field on the west side of the highway. This is not completely speculation because the photograph of the accident site taken by the news media while the vehicles were still at their rest positions showed that such a snow drift existed. This snow was deeper in the southbound lane than it was in the northbound lane.

The photograph also showed that the north edge of this snow drift was about 4 to 5 hatched lines south of the point where those hatched lines of the centre-line terminated. We know from previous investigations that a single hatched line is about 3 metres long and that the gap between each of those lines is usually about 6 metres long. If we added four of those hatched lines and four gaps we would get a distance of about 36 metres. So we could estimate that the snow drift ended about 36 metres south of where the hatched lines came to an end.

In the photograph shown on the following page we show a view looking northbound from several hundred metres south of the area of impact. Note that the road surface in the foreground is damp or wet and in the distance it becomes dry.

The road is damp because this is approximately where the snow drift was located and there was not enough time to dry out the surface before we took this photograph on the following day. If we were involved in an official investigation we would confirm this through proper measurements and observations of the positioning of the hatched lines of the centre-line. But for now this is a reasonable conclusion.

It would be a simple procedure to note the distance of this snow drift to the location of the point of impact and then compare that distance to other loss-of-control collisions to determine whether the position of the snow drift was such that it could be the cause of the loss of control of the Avalanche. For now we will conclude that indeed it was a factor in the causing the loss of control.

So what might have happened?

A heavy snow squalled was reported in the area and visibility was poor. But such a snow squall does not last for a long time nor does it exist over a large area. So it is quite reasonable that the driver of the Avalanche could have been travelling over a relatively bare road surface where his speed could have been close to normal just before he encountered the snow squall. Even upon entering the area of the snow squall it is likely that the road on which he was travelled had not become fully engulfed with snow. In fact, judging by the conditions that we experienced in our road testing just north of the accident site just an hour or two after the collision there were likely an number of bare areas on the road and then suddenly a snow drift would be encountered. We were not driving in the heavy snowfall that accompanies a snow squall so we were easily able to see the snow drifts as we approached them. But the driver of the Avalanche likely did not have that ability to see ahead of him. Note also that the location where he started (Embro) his trip was not very far away and therefore his was probably not driving on the highway long enough realize that he might encounter deep snow drifts. So as he travels at relatively high speed the heavy snow does not give him much concern because the road surface is realively bare. But then he suddenly encounters the snow drift.

I say suddenly because, in the expected heavy snowfall and lack of a long visibility distance, along with his higher speed, he would likely come upon the snow drift very quickly. Even in our testing we found a couple of situations where snow drifts seemed to appear quite suddenly and we even remarked about that fact and it can be heard in the audio portion of our videotaped testing. Yet we did not encounter the heavy snow fall of a snow squall.

What would happen if our driver suddenly encountered a snow drift that he was not expecting? Almost all of us would recognize that we were travelling too fast for the upcoming road condition and we would apply our brakes. The timing of the brake application is very critical. If he applied his brakes and then released them as he entered the drift then this is the best that he could achieve. But if he maintained his brake application while going into the snow drift then this could be a disastrous consequence. Because, as our Test 14 demonstrated, if the snow drift was only partly across the lane in which he travelled then hard braking would cause an unequal force to be applied between the left and right side wheels. This would cause a moment that would commence the vehicle's rotation.

One would argue that the initial rotation would be clockwise and this would tend to push the vehicle toward the right (east) side of the road and away from the area of impact. But, as is commonly demonstrated in loss-of-control collisions, the factor that first initiates the loss-of-control can be several hundred metres away from where the vehicle eventually collides. And during this long distance the driver is involved in several steering and/or braking motions in which he tries to gain control of the vehicle. It has been observed by many experts that such actions to counter the rotational motion of the vehicle are often too late and simply aggravate the loss of control such that the weaving back and forth eventually results in a critical angle where no steering will make the vehicle recover and a crash occurs.

Note from our testing what a big difference there is in the aggressiveness of the road surface between snow-cover and bare pavement. Note how much faster the vehicle will want to reduce speed when its tires encounter bare pavement. And look at how long the vehicle wants to slide on snow. It is not surprising that a difference in surface conditions could destabilize a vehicle and cause a crash. But note also that there are substantial differences in deceleration even in snow-covered road conditions that appear to have similar characteristics. When a road surface is very slippery the smaller differences in deceleration level begin to have a greater determination as to whether a vehicle will enter in to a state of loss of control. This is logical.

We have performed an number of braking tests throughout the month of February, 2012 on a number of roads in the vicinity of London, Ontario. We have not decided whether we will continue to post results of the rest of our findings.

We find our test procedure involving multiple video cameras need not be supplemented with an accelerometer as we are not interested in the details of how the deceleration pulse changes throughout our test. A single, average rate of deceleration is all that is necessary to distinguish one road surface from another especially when the test occurs over so many seconds.