Duplication of Tire Marks Observed On A Gravel Shoulder Through Controlled Testing

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Over the years the S-curves on Clarke Road north of Fanshawe Park Road in the north-eastern outskirts of London, Ontario have been the site of many tests and observations performed by Gorski Consulting. In the latest testing we have documented a set of tire marks caused by a northbound vehicle on the east gravel shoulder of this site. We performed a test to see if we could replicate its characteristics. This article will provide details of the observed tire marks as well as the tire marks from the test that were created to explore the meaning of the observed marks.

Description of the Observed Tire Marks

It has been customary for Gorski Consulting to attend to the site of the S-curves on Clarke Road in London, Ontario to document a variety of data related to loss-of-control collisions, tire marks on gravel shoulders, and controlled testing. On one of our excursions on December 4, 2013 we documented a set of tire marks from a northbound vehicle that travelled on the east gravel shoulder and performed a U-turn to travel back southbound. This action was performed shortly after the gravel shoulder had been freshly graded by a road grader thus the gravel was loose and the tire marks were well preserved.

Figure 1 shows a view, looking southward, along the east gravel shoulder of Clarke Road, where the northbound vehicle travelled onto that shoulder, likely stopped, and then performed a sharp left turn to make the U-turn. These tire marks were clearly visible because of the looseness of the gravel caused by recent re-grading. This set of tire marks overlaps a tire mark produced by a large, tractor-like vehicle that has passed through the shoulder at an earlier time.

Figure 2 also shows a southward view of the same curve but it is a view of the opposite, west shoulder, where it can be seen that, as the vehicle made the U-turn, its right side tires travelled onto the west shoulder and produced the clearly visible tire marks shown in this figure.

Returning to the east shoulder, Figure 3 provides a closer view of the tire marks produced by the right side tires of our turning vehicle in the vicinity where it stopped and then made the sharp left turn. In fact, Figure 3 shows a clear view of the right front tire mark in the foreground and we can see that the sharp change in direction of the mark is because the driver turned the front wheels sharply to the left. Further in the background we can see the classic curvature of the right rear tire mark which has the gentler change in direction as it follows a different path to the right front tire during the sharp turn.

Figure 1: View, looking southward along the east shoulder of Clarke Road where a vehicle produced tire marks before making a sharp U-turn.

Figure 2: View, looking south, of the west shoulder of Clarke Road where the U-turning vehicle's left side tire produced the tire marks as it returned to travel back southward from where it came.

Figure 3: Closer view of the tire marks produced by the right side tires of the northbound vehicle with the tire mark from the right front tire in the foreground.

An interesting feature of the right front tire mark is that we do not see the imprint of any tire tread, as if the tire is bald. This is evidenced further in Figure 4 where we see the junction of the two right side tire marks and the right rear shows the imprint of its tread.

In Figure 5 we see the path of the left front tire in the centre of the view and it contains more upheaval of the gravel/sand in the vicinity of its change in direction which is shown in close up in Figures 6 and 7. Recall that the left side tires are travelling over the previously created tire mark of the large tractor-like vehicle so it is more complicated to distinguish the two.

Certainly there appears to be more upheaval in the gravel and sand at the point where the left front tire is beginning its change in direction. Our belief is that this occurs because this tire tracks a more severe curvature, or a smaller radius, than the right front tire and this causes the tire to "shudder" as it is required to perform the sharper turn.

Figure 4: View of the tire mark from the right rear tire as it diverges from the path of the right front tire during the left turn.

Figure 5: The tire track of the left front tire of the mystery vehicle can be seen in the centre of this view and its sharp change-in-direction can be seen in the foreground. At the left edge of the view is the curving mark produced by the right rear tire.

Figure 6: View, showing the change-in-direction of the left front tire (to the right) and the curving right rear tire mark (to the left).

Figure 7: Close-up view of the "shuddering" marks in the left front tire mark during it sharp left turn.

We have now reviewed the characteristics of the tire marks that were found at the site. In order to provide some indication of how these tire marks were produced we conducted a test with our vehicle in which we travelled onto the shoulder at approximately 60 km/h and applied relatively hard braking until our test vehicle came to a stop. While our vehicle was stopped we then turned our steering wheel fully to the left and then accelerated, performing a U-turn that carried the right side tires of our vehicle onto the west shoulder, just like the tire marks that were found.

Figure 8 provides a view of our test vehicle, looking south, on the east shoulder where we brought it to a halt before proceeding with the sharp, left, U-turn.

Figure 8: View, looking south, at the test vehicle after it was brought to a halt along side of the tire marks that were previously found and discussed above.

Figure 9 shows the vehicle's right tires while Figure 10 shows the left tires. Figure 11 shows the area just behind the test vehicle. Figure 12 shows a view, looking south along the east shoulder to the area where the test vehicle exited the pavement. The right side tires from the test vehicle produced the mark that is approximately in the middle of the figure whereas the tire mark from the mystery vehicle is just to the right.

Figure 9: View of right tires of test vehicle on east shoulder.

Figure 10: View of left tires of test vehicle on east shoulder.

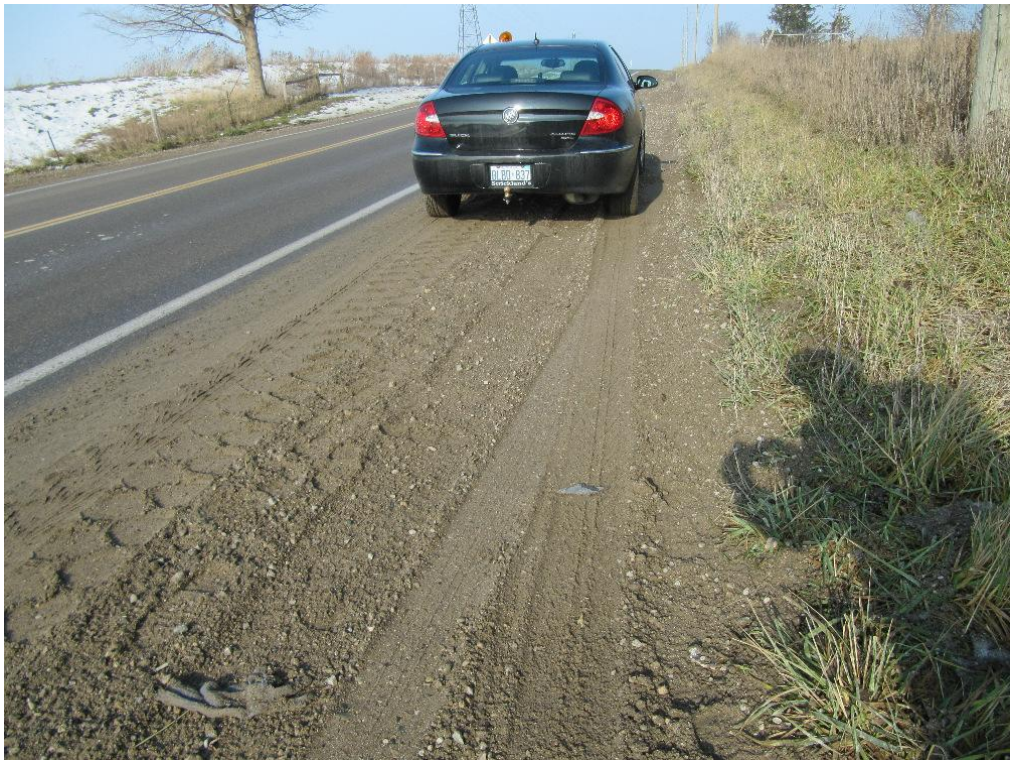

Figure 11: View, looking north toward the test vehicle on the east shoulder.

Figure 12: View, looking south, at the tire mark caused by the right side tires of the test vehicle (centre of view) and the right tire mark caused by the mystery vehicle (to the right).

In our test we applied fairly aggressive braking shortly after exiting onto the east shoulder and this is evidenced by the upheaval shown within the tire mark in Figure 12. Note that further in the background the tread of the tire is more visible while closer toward the foreground we can see more upheaval. So this is the effect of aggressive braking.

Figure 13 is another view looking south but taken from further north or closer to the stopped position of the test vehicle. Here it possible to obtain a better comparison between the tire mark caused by the right side tires of the test and mystery vehicles. One observation is that the mark from the mystery vehicle has the character of being caused by a "rolling pin" in that there is little evidence of any imprint of the treads of the tires and the edges of the mark are very well defined. There is no evidence of any upheaval within the mark. The tire mark is also very straight.

In contrast, the tire mark produced by our test vehicle shows the tread of the tires within it in some areas whereas in others there is an upheaval as some of the gravel and sand has been thrown up and has landed within the mark during the aggressive braking. The mark is also slightly curved as a result of our steering. The edges of the mark are also not well defined.

Figure 13: View, looking south, showing the mark caused by the test vehicle (left) and the tire mark caused by the mystery vehicle (right).

The difference becomes more obvious in Figure 14 when the two tire marks merge and we see them side-by-side. Obviously, our test was performed after the mystery vehicle

passed through so the tire mark from our test obliterates the marking from the mystery vehicle in the foreground of Figure 14. The lack of a tread imprint in the mystery vehicle tire mark is very obvious here.

Figure 14: View, looking south, as the tire mark from the right side tires of the test vehicle merge with the tire mark caused by the mystery vehicle.

The extent of our strong braking is evident in Figures 15 and 16, which are views of the right front tire mark of the test vehicle and we can see the build-up of gravel/sand in front of the tire as the gravel/sand has been pushed forward.

Once we completed our photos of our test vehicle at its rest position we re-entered the vehicle, turned its steering wheel fully to the left and then accelerated into a U-turn. Figure 17 shows a view of the resultant tire marks from that motion as we see some of the sand and mud have been deposited on the pavement as the U-turn was made.

Figure 18 shows a view from the east roadside, looking west and showing the tire marks produced as the test vehicle made the sharp U-turn from a stopped position.

Figure 15: View of right front tire of test vehicle showing the buildup of gravel/sand in front of the tire where it came to a halt.

Figure 16: View of right front tire of test vehicle and the character of the mark in the gravel/sand at its rest position.

Figure 17: View of the tire marks produced after the steering wheel was turned fully to the left and a U-turn was made.

Figure 18: View, looking west, across the road where the test vehicle made a sharp U-turn toward the west shoulder.

Figure 19 shows an overall view of the tire marks created on the west shoulder by the mystery vehicle and by our test vehicle. Both sets of marks were created by the right side tires of each vehicle.

Figure 19: View, looking south, at the tire marks caused by the mystery vehicle and our test vehicle as both vehicles progressed through their U-turns.

Figures 20 and 21 provide further views of the two sets of tire marks on the west shoulder. Overall, the marks are similar in their geometry. Obviously the right front tire extends further into the shoulder than the right rear, as would be expected in such a sharp left turn. Figure 21 provides an especially clear view of the two sets of tire marks, side-by-side, as the two right side tires converge at the end of the turn at the point where the vehicles re-enter the paved road surface. It evidence continues to show that the right tire of the mystery vehicle appears to be bald in that it does not imprint a tread, in contrast to the right rear tire of the vehicle which shows its tread. In fact, examination of the previous photos confirms that both front tires of the mystery vehicle were bald as neither of the tire marks from these tires imprinted a visible tread.

Figure 20: View, looking south, of the two sets of tire marks on the west shoulder.

Figure 21: View, looking south, of the two sets of tire marks, the mystery vehicle to the left and the test vehicle to the right.

Returning to the east shoulder, we can conduct some detailed observations of the tire marks from the two vehicles. Figure 22 provides a southward view of the tire marks at the location where our test vehicle was stopped and then accelerated into its U-turn.

Figure 22: View, looking south, at the tire marks produced by the mystery and test vehicles.

While the view in Figure 22 looks rather complicated, one can refer to the photos in the previous sections to separate which marks are from which vehicle. In the foreground the tire marks from the mystery vehicle are located just slightly to the left of those caused in our test. Also the U-turn from our test was performed a little south of the one performed by the mystery vehicle. So, in Figure 22, one can see the point where our test vehicle's right front tire was stopped and then was turned into the U-turn, whereas the same point from the mystery vehicle is out of view and is located just behind the camera.

Figure 23 provides a close-up view of the change-in-direction of the right front of the test vehicle while Figure 24 shows that same location with respect to the left front tire.

Figures 25 and 26 show the locations where the right and left rear tires of the test vehicle diverge from the paths of their respective front tires at the beginning of the U-turn.

Figure 23: View, looking south, of the point where the right front tire of the test vehicle changes direction into the U-turn.

Figure 24: View, looking south, of the point where the left front tire of the test vehicle changes direction into the U-turn.

Figure 25: View, looking south, at the point where the right rear tire's path diverges from its right front tire at the beginning of the U-turn. These marks overlap the tire mark from the mystery vehicle.

Figure 26: View, looking south, at the point where the left rear tire's path diverges from its left front tire at the beginning of the U-turn. One can also see the tire mark from the mystery vehicle and the older mark from the tractor in this view.

Figure 27 provides a view of the acceleration mark caused by the right front tire as the vehicle moved from its stopped position into the U-turn. One can detect, within the tire mark, how there are scalloped "shudder" marks indicating that the gravel/sand beneath is being pushed rearwards as the tire accelerates forward. This was a fair aggressive acceleration that had to be performed into the U-turn because of the limited visibility in the curve. So the evidence shown here represents what characteristics would exist during such an aggressive U-turn.

To summarize our work, on December 4th, 2013 we observed a set of tire marks on the S-curve of Clarke Road north of Fanshawe Park Road and we noted that the characteristics of these marks were clearly visible due to the fresh re-grading of the shoulder that had recently been performed by road maintenance personnel. This gave us an opportunity to conduct a test on this loose gravel by driving onto the shoulder, coming to a halt and then performing a U-turn, in a similar manner to the marks produced by the mystery vehicle.

Having examined the marks from the test vehicle and from the mystery vehicle it is our opinion that the mystery vehicle was likely travelling much slower than the 60 km/h driven by the test vehicle.

We say this because, while travelling onto the shoulder during our test, we had a short time to bring our vehicle onto the shoulder and then straighten it out. This required that our steering inputs to the right and back to the left be more pronounced than if we were travelling at a much slower speed. For example, if we had been travelling very slowly we would have much more time to bring the vehicle onto the shoulder and a similarly long time to straighten the vehicle to make it travel parallel to that shoulder. So this additional time means that we would not need to input such dramatic steering as we did when travelling faster. So, at the slow speed our tire mark would be straighter, or similar to the straightness of the tire mark created by the mystery vehicle.

We also believe the mystery vehicle was travelling slowly because of the " rolling pin" type of flattening of the gravel/sand within the tire marks and the sharp, well-delineated edges of the marks. In contrast, the tire mark from our test contains areas within the marks where the gravel appeared to be in upheaval, as one would expect at higher speed and during the significant braking that had to be performed within the shortened time to bring our vehicle to a halt.

In all we are satisfied with the detail that was available to be documented in these marks due to the looseness of the gravel/sand surface. Such details would not reveal themselves if the shoulder had not been freshly re-graded. This is the problem in many serious collisions on rural highways where gravel shoulders are hard packed. An investigator can have great difficulty trying to determine if a vehicle travelled onto a hard-packed gravel shoulder because any tire marks will be difficult to detect. In many instances investigators come to the believe an entrance onto a gravel shoulder did not occur simply because they could not detect a tire mark rather than recognizing that such a conclusion often cannot be made under such conditions.

When a gravel shoulder is soft from moisture or from recent re-grading the investigator should understand that tire marks are likely to be produced and then one should have sufficient training about the characteristics of such marks to be able to understand what they mean.

There are occasions where tire marks are produced when a gravel shoulder is soft and then those marks can become solidified (if they are not destroyed by other traffic) as the shoulder hardens such that those tire marks might remain visible for a much longer time than one might believe possible. This is sometimes the case during winter conditions where a short term thawing produces the wet and soft conditions to allow tire marks to be produced and then a sudden cold spell freezes those marks into a

fossilized state. Thus it would not be surprising for such marks to remain visible for a number of weeks.

Unfortunately, where tire marks are created on a gravel shoulder it is often due to a road curvature or some other geometric character of the road which causes other vehicles to enter the shoulder at the same location. Thus many such tire marks are short-lived because they are destroyed by other traffic.

Similarly, it is very common at the site of a serious motor vehicle collision on a rural highway for well-meaning passers-by to pull their vehicles over onto the shoulder to run to help out some persons involved in the crash. In doing so they often destroy key tire mark evidence on the shoulders that might reveal that a vehicle was out-of-control prior to the collision.

Similarly police, ambulance and fire personnel are understandably more focused on the issues of rescuing persons from possible death rather than thinking about any evidence that might be destroyed. This is often an unavoidable reality and must remain so. However, where possible, quick-thinking, persons who understand the importance of tire marks on gravel shoulders can work to preserve that evidence if they have some idea where it might be located and what it looks like.

It is our intent to continue with our research in this area. There is little information or research data available in the area of interpretation of tire marks on gravel shoulders. Yet, such marks are often important clues to how and why major collisions occur on rural highways.

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