Creation of Braking & Acceleration Tire Marks on a Gravel Shoulder to Replicate Marks Caused by An Unknown Vehicle

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At Gorski Consulting we continue to study the characteristics of tire marks on gravel shoulders of roadways in order to better understand the evidence that exists at the site of many serious, loss-of-control collisions. This is an important endeavor because a large number of serious-injury and fatal collisions in North America originate from a vehicle's travel onto to a gravel shoulder of a rural road. While new technology such as event data recorders may provide valuable clues about the pre-crash conditions, it is unlikely to replace the additional value obtained from a thorough understanding of the physical evidence found at an accident site.

Interesting tire marks can be found along the gravel shoulders of rural highways in non-collision circumstances and these can be explored to understand how they might have been created. As an example, a set of tire marks was located on a gravel shoulder of a semi-rural road on the outskirts of London, Ontario, Canada, and an attempt was made to produce similar tire marks next to them as a method comparison and consideration of how the original marks might have been produced.

In Figure 1 we show the general area of the east shoulder of Clarke Road, looking north, just south of Fanshawe Park Road in London, Ontario, where an unknown vehicle had produced a set of tire marks in the soft and wet gravel shoulder. Those soft and wet conditions were ideal for the production of good-quality tire marks whose characteristics were easily visualized. Figure 2 shows another view of the area a little closer to the portion of the tire marks that are of primary interest.

Based on previous experience the tire marks were indicative of a northbound vehicle that travelled onto the east, gravel shoulder under the condition where its tires were rolling. Then the vehicle entered into an abrupt acceleration that took the vehicle back onto the paved road surface.

The detailed characteristics of these tire marks are documented in Figures 3 through 6.

Our test vehicle (2007 Buick Allure) was driven northward along this gravel shoulder at a speed of 20 km/h. Just before reaching the point of acceleration of the original tire marks the brakes were applied to their maximum for very short time interval, followed by an equally quick and maximum application of the acceleration pedal. The resultant tire marks from this action was shown in Figures 7 to 11.

Figure 1: View, looking northward, along the east shoulder of Clarke Road in London, Ontario where a set of tire marks is visible in the background of the gravel shoulder.

Figure 2: View, looking north, along the east shoulder of Clarke Road close to the location where an unknown vehicle made an abrupt acceleration back onto the paved road surface.

Figure 3: View of right tire mark at commencement of acceleration

Figure 4: View of left tire mark at commencement of acceleration

Figure 5: View of right tire mark past the commencement of acceleration.

Figure 6: View of left tire mark past the commencement of acceleration.

Figure 7: Overall view, looking north, at the new set of tire marks produced by our test vehicle, alongside the original tire marks produced by the unknown vehicle.

Figure 8: View looking along the left side tire mark produced by the test vehicle.

Figure 9: View, looking along the right side tire mark produced by the test vehicle.

Figure 10: View of the left side tire marks produced by the test (left of view) and unknown (right of view) vehicle.

Figure 11: View of right side tire marks produced by the test (left of view) and unknown (right of view) vehicle.

Analysis & Discussion

The gravel shoulder where the tire marks exist is on an upgrade as directly to south there is a bridge to the north branch of the Thames River, as shown in southerly view of Figure 12 below.

As typical, one would also expect that there would be a substantial cross-slope in the shoulder of at least 4%, banked away from the paved roadway. Such slopes would affect the motion of the vehicles producing the noted tire marks.

In the tire marks caused by the test vehicle, the functioning of the anti-lock braking system (ABS) is apparent from the visible patches of disturbed gravel that exist just before the darker area of the commencement of the acceleration. No such patches exist in the tire marks produced by the unknown vehicle therefore it is likely that such maximum braking did occur before the acceleration.

When a front-wheel-drive vehicle accelerates hard on gravel the front tires may spin causing the disruption of the gravel, often with dispersion of the gravel to the right and left the tread path. However the rear tires that follow behind the spinning front tires will simply roll over top of the disrupted gravel and this is what we see in both sets of marks produced by the test and unknown vehicles. Thus the unknown vehicle was likely a front wheel drive.

Figure 12: View, looking south, showing that the shoulder is on a northward upgrade due to Thames River bridge in the background.

A curious occurrence is visible in the unknown vehicle's tire marks after the point of initial acceleration, as shown in Figure 5 (right tires) and Figure 6 (left tires). It would appear that the upheaval of the gravel caused by the front tires is located on the outboard side of the imprints caused by the rolling rear tires. It is as if the track width of the front tires was smaller than that of the rear tires. In contrast, when we look at the tire marks produced by our test vehicle, the upheaval of the gravel caused by the test vehicle's front tires is dispersed approximately equally to the right and left of the rear tire tracks. In other words, the rear tires of the test vehicle simply follow the path of the front tires, but also, those rear tires are neither outboard or inboard of the front tires.

One could believe that this curiosity was from the occurrence of a slight bit of yaw by the unknown vehicle. In other words, as a result of the acceleration, the unknown vehicle rotated slightly about its vertical axis. However that would not explain the evidence. If yaw occurred then **both** of the front tires would either be located outboard or inboard of the rear tires. However that is not what is visible in the above figures. In the above figures it appears that, during acceleration, both of the front tires were pulled inboard, or at least existed inboard of both of the rear tires. This could be explained if the weight of the vehicle was rolled off the front end slightly due to high acceleration. However we are not concluding that this occurred. We offer this comment as a way to promote further discussion.

When gravel shoulders become wet they are also soft and become an excellent medium upon which the characteristics of tire marks can be clearly visualized. However this is also a greater danger to the travelling public as softer gravel is able to create a greater difference in tire force compare to the pavement of a road. Thus if the right side tires of a vehicle happen to enter onto that soft gravel the difference in tire force from the left side tires on the paved roadway could increase the likelihood of a loss-of-control of the vehicle.

A true difficulty occurs when gravel shoulders become hard and dry, particularly in summer months, but also in cold winters when the gravel becomes frozen. In those circumstances the travel of a vehicle onto that hard gravel may leave very little visible evidence. It becomes even more important to obtain a firm grasp of the meaning of the evidence on soft shoulders so that, when the evidence becomes more difficult to see on a hard/dry shoulder, the investigator can pull out whatever is possible from that fragile and difficult evidence.

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