Rough Roads, Increasing Speed and Change in Test Vehicle Motion - Additional Data

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In an earlier article (posted on this same date of March 6, 2014) we reported on the data obtained from driving our test vehicle westbound over a poor road surface (Sunningdale Road in London, Ontario). After reporting those results we indicated that testing had also been performed in an eastbound direction and that the results of that testing would be reported in an upcoming article. This is the upcoming article.

Since it might be possible that some readers might not have access to the earlier article we will review the procedures portion of the previous article before providing the test results.

Review of Testing Procedure

A 2007 Buick Allure passenger car was equipped with multiple video cameras at the following locations:

1. Mounted to centre dash and pointing forward through the windshield.
2. Mounted in front of instrument cluster and documenting the status of the Speedometer, Tachometer and other instruments.
3. Mounted to the driver's sunvisor and pointing rearward at the driver's head.
4. Mounted to the centre console and pointing downward upon the face of an iPhone displaying the sensed values of lateral and longitudinal motion of the centre-of-gravity of the test vehicle.
5. Mounted underneath the left end of the front bumper and pointing forward to display a close-up view of the road surface.
6. Mounted to the right end of a lateral bar that was anchored to a bicycle rack at the rear of the vehicle. This camera was pointed forward and documented the right side and taillights of the test vehicle.

The test vehicle was driven westbound along Sunningdale Road in London, Ontario, commencing from the intersection of Clarke Road and terminating near the intersection of Highbury Avenue, as shown in Figure 1.

The distance over which the testing was conducted was about 2 kilometres.

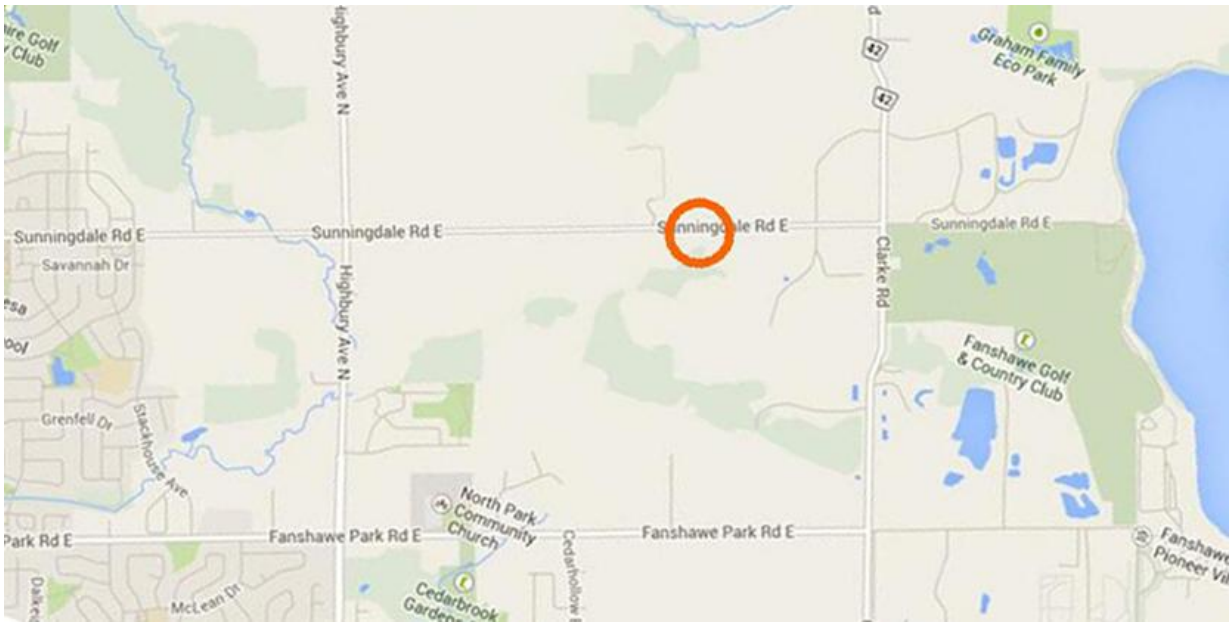

Figure 1: View of testing location on Sunningdale Road in London, Ontario, Canada, commencing at Clarke Raod to the east and terminating near Highbury Avenue to the west.

Sunningdale Road was generally straight and level except for a small sag located near its east end. There was a small bridge at the bottom of this sag as shown in the westward view of Figure 2.

An Apple iPhone 4S was used as the instrument that sensed the changes in the test vehicle's lateral and longitudinal motion.

The testing was begun at the intersection at Clarke Road where the test vehicle was at a stopped position. The "record" button on the iPhone was activated and they the vehicle was accelerated to the desired speed. While travelling westbound the vehicle passed over the old pavement, some of which is shown in Figure 2. At the approximate location of the small bridge (shown in the background of Figure 2) the section of new pavement was encountered. As the vehicle progressed further westward the new pavement terminated and the vehicle began travelling on the old pavement. Shortly afterward, on approach to the intersection of Highbury Avenue, the vehicle was stopped on the north shoulder, the "pause" button was activated on the iPhone and the data file was sent by e-mail to a remote computer. The vehicle was then turned around and another run was performed in an eastbound direction. This process was repeated at travel speeds of 40 through to 90 km/h, at 10 km/h increments.

In the earlier article we only presented the data from the westbound runs. However, as the analysis of the eastbound data took a shorter time to process than we expected we have prepared this second article to show the results from the eastbound runs and to compare them to the westbound runs.

Figure 22: View, looking west along Sunningdale Road, near the location where data collection was commenced. In the background is a sag and small bridge which is the only significant elevation change in the road segment.

Review of Test Results

When the e-mailed data file was retrieved at the office, it was converted into an Excel spreadsheet. Part of the data file reported the rate-of-change of the lateral and longitudinal motion of the vehicle and these two parameters were selected for further review. This rate-of-change in the angle of the vehicle was reported in radians per second. There are 57.3 degrees in one radian. As a measure of the dispersion and differentiation of the data it was decided to take the standard deviation of the of the data points. This would provide a simple way of showing how quickly the vehicle moved away from its "mean", level position. Figure 3 summarizes the results from the westbound runs while Figure 4 summarizes the data from the eastbound runs.

In the charts of Figures 3 and 4 the blue line indicates the lateral motion while the red line indicates the longitudinal motion of the test vehicle. The axis along the bottom of the chart indicates the increasing speed of the test vehicle, from 40 to 90 km/h. The vertical axis is expressed in radians per second, from the minimum of 0.0300 to the maximum of 0.0700.

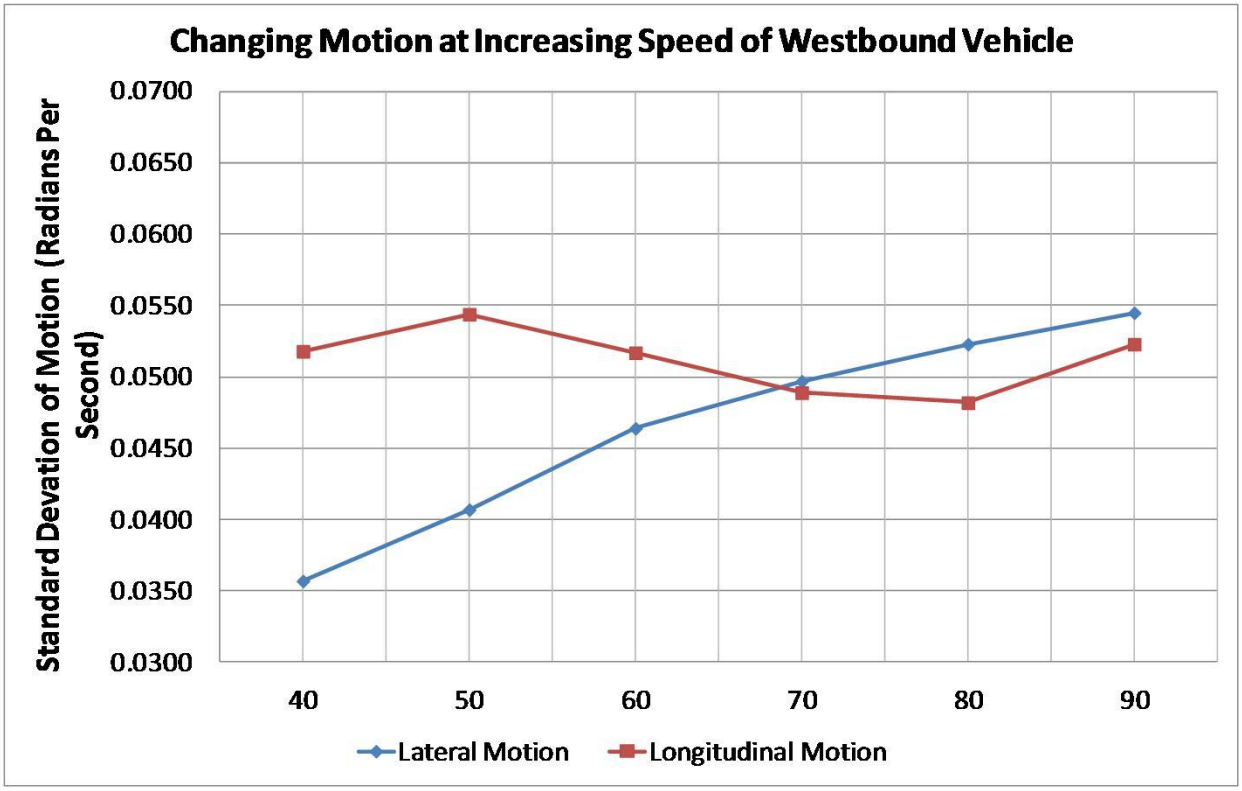

Figure 3.

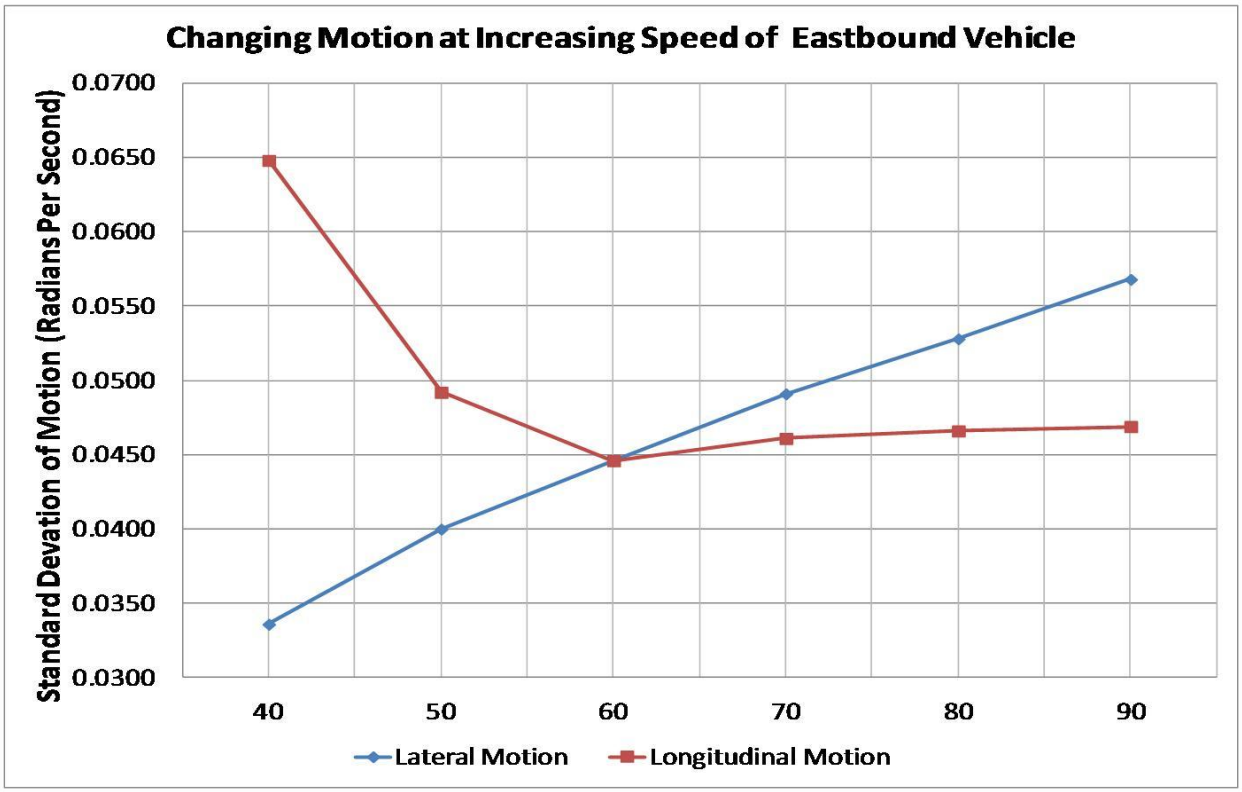

Figure 4.

In the earlier article we referred only to the data in Figure 3. We noted that, at the low speed of 40 km/h the rate-of-change in the longitudinal motion was much higher than it was for the lateral motion. However, as the speed was increased, the rate-of-change of the longitudinal motion stayed relatively the same, or perhaps it might even show a reducing trend with increasing speed. However, we noted that the rate of change in the lateral motion rose significantly as the speed of the test vehicle was increased such that, in the last three highest speeds (70, 80 and 90) the lateral motion was higher than the longitudinal motion.

The new data in Figure 4 re-affirmed what we indicated in the earlier article. However, the drop in the longitudinal motion seemed more apparent as the speed of the vehicle was increased, although the relationship was not as smooth. In contrast, the lateral motion data seemed to exhibit a steady incremental increase that matched very well with the incremental increase in vehicle speed.

These are interesting results. It cannot be known how this finding can be generalized to other sites and other test vehicles. However we will be monitoring this relationship as we continue to gather more data from our testing.

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