NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Washington, D.C. 20594

September 14, 2018

Video Study

NTSB Case Number:
HWY17MH015

A. ACCIDENT

Location:	Flushing, New York
Date:	September 18, 2017
Time:	6:16 a.m. EDT
Vehicle:	2015 MCI Motorcoach

B. AUTHOR

Dan T. Horak
NTSB

C. ACCIDENT SUMMARY

For a summary of the accident, refer to the *Crash Summary Report* which is available in the docket for this investigation.

D. DETAILS OF INVESTIGATION

The goal of this study was estimating the speed of the motorcoach as it was approaching the accident location based on video recorded by a forward-facing camera. The camera was built into a Garmin dēzlCam LMTHD navigation unit that was mounted in the motorcoach. The Garmin unit computed motorcoach speed based on GPS locations. These speed estimates were refreshed once per second and overlayed on the video. It is not known whether the Garmin unit estimated speed over one second or over a longer time interval.

This study estimated speed based on pavement joints on Northern Blvd. (NY 25A) that were visible both in the video and in Google Earth. This was done independently of the Garmin GPS-based speed estimates. The video had resolution of 1920x1080 and frame rate of 30 fps. The first pavement joint considered was the one just east of the elevated I-678 segment closest to Flushing Creek. The last considered motorcoach location was not a joint but an 'ONLY' pavement marking just west of Prince street. The

motorcoach traveled this west to east distance of approximately 1600 feet in approximately 24 seconds.

There were total of 21 motorcoach locations considered (20 joints and one pavement marking). Consequently, there were 20 speed estimates, the first at the second visible joint east of I-678 and the last at the 'ONLY' pavement marking just west of Prince street. Each estimate was across the distance between two adjacent joints and the speed was assigned to the location of the east end of that road segment. The traveled distance between adjacent joints was measured in Google Earth and the elapsed time was based on the time stamps on the video frames.

Figure 1 shows an aerial map of Northern Boulevard with 20 marked locations (19 joints and one pavement marking) at which speed was estimated based on the video. Figure 2 shows the estimated speeds. The point numbers in Figure 2 correspond to location numbers in Figure 1.

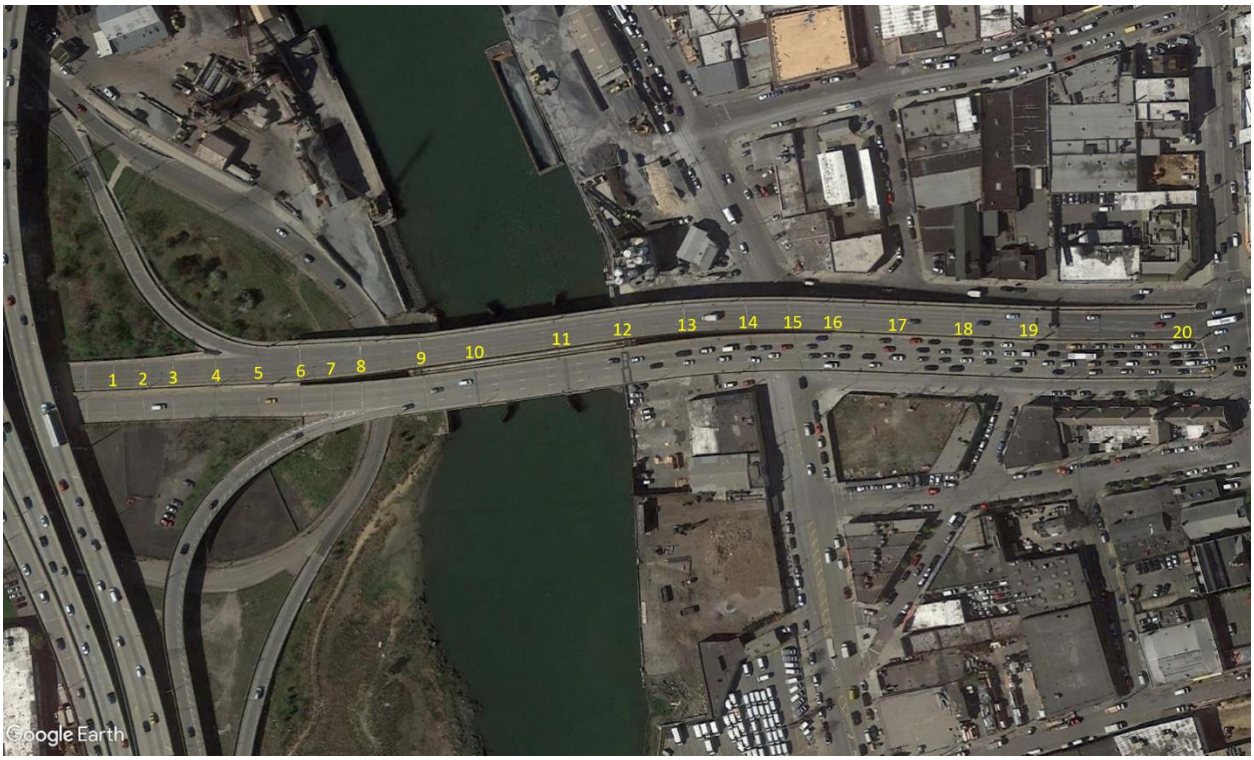

Figure 1. Locations at which Speed Was Estimated

The solid line in Figure 2 is the nominal speed estimate and the dotted lines mark the tolerance of the estimated speeds. The tolerances account for inaccuracies in estimating the video frame when the motorcoach was at a joint location, a process that required interpolation between frames. Note that the tolerance band is smaller when the distance over which speed was estimated is long and is larger when the distance is short.

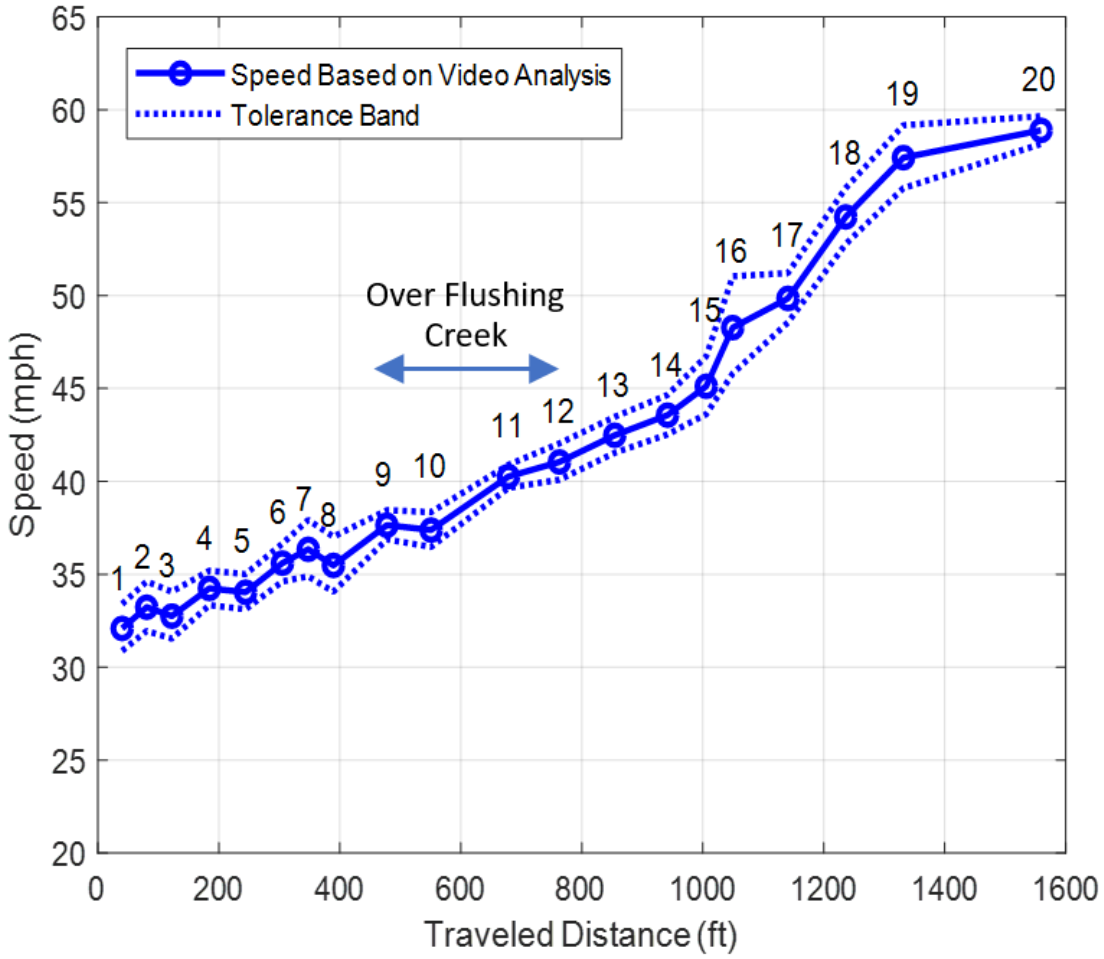

Figure 2. Estimated Speed vs. Traveled Distance

Figure 3 compares the video-based nominal speed estimates with Garmin GPS-based speeds. Both curves are shown vs. time. The video-based speed points are at the times when the motorcoach was at the locations shown in Figure 1. The Garmin GPS-based speeds at one second intervals corresponding to times when speeds were updated and overlayed on the video. The speed curves are in close agreement up to time 18 seconds. Past that time, the video-based speed estimate is somewhat higher.

Motorcoach Acceleration

Figures 2 and 3 show that the motorcoach was accelerating during the entire analyzed distance. This included the approach to the bridge over Flushing Creek on a 5.5% upward sloped road. It continued accelerating once it was past the bridge on a 5.3% downward slope. The acceleration between points 1 and 15 was approximately 0.03 g.

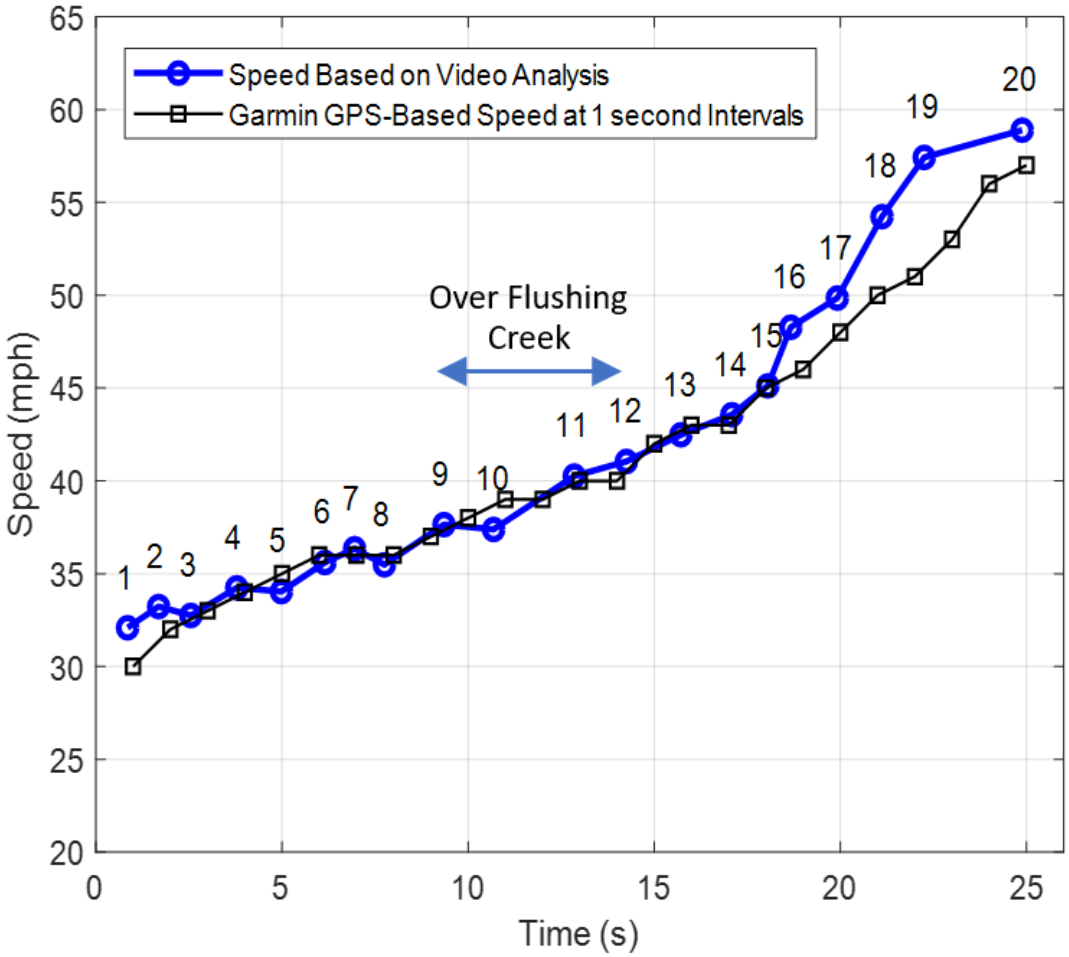

Figure 3. Video-Based Speed and GPS-Based Speed Estimates

When the motorcoach was accelerating on the upward-sloping road, the acceleration had to be due to power supplied by the engine. Without power supplied by the engine, the motorcoach would have decelerated.

The analysis of acceleration on the downward-sloping road segment requires consideration of frictional losses. The acceleration of an object on a frictionless 5.3% downward-sloping surface is 0.053 g. Past point 15, the acceleration was about 0.1 g, about twice as much as what the downward slope there could cause. Therefore, power developed by the engine had to contribute to the acceleration of the motorcoach in that segment.

Between points 12 and 15, on a downward slope, the acceleration was about 0.03 g. Theoretically, it is possible that the 0.03 g acceleration on the downward slope was due to the slope and frictional losses reduced it from 0.053 g to 0.03 g. There are three main sources of frictional losses that affected the motorcoach. They are aerodynamic drag, tire-road friction, and powertrain friction. The magnitudes of these losses are unknown. If the contribution of these losses to motorcoach deceleration was more than

0.053-0.03=0.023 g, the engine had to supply the power required to keep the acceleration at 0.03 g. If the contribution was 0.023 g, then the engine was not supplying power. Given the available information, it is not possible to determine if the engine was or was not supplying power between points 12 and 15.

E. CONCLUSIONS

Video acquired by a camera mounted in a motorcoach was used for estimating the speed of the motorcoach. The estimated speed agreed well with a GPS-based speed estimate over most of the analyzed distance.

The motorcoach was accelerating during the entire analyzed distance. It was accelerating on the upward-sloping road leading to the bridge over Flushing Creek. On a road segment past the bridge, it was accelerating at a rate higher than what the downward slope there could have caused. Therefore, it is concluded that during most of the analyzed distance, the engine was delivering power that accelerated the motorcoach.