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

March 22, 2016

Video Study

NTSB Case Number:
DCA16MR004

A. ACCIDENT

Location: Cimarron, Kansas
Date: March 14, 2016
Time: 12:02am CST
Vehicle: Amtrak train #4 (Southwest Chief)

B. AUTHOR

Dan T. Horak
NTSB

C. ACCIDENT SUMMARY

On March 14, 2016, at 12:02am CDT, Amtrak train #4 (Southwest Chief) derailed near MP372.9 in the vicinity of Cimarron, KS. This LA to Chicago train consisted of two locomotives and 10 cars. Four cars were derailed on their sides, one car derailed and was leaning, two cars derailed upright, and one car derailed a single truck. There were approximately 130 passengers and 14 crew members on board. Initial reports indicated that between 10 and 33 passengers were transported and/or treated for injuries at two area medical centers. The American Red Cross responded to assist with passengers.

This event occurred on the BNSF Railway Company (BNSF), La Junta Division. The maximum allowable speed on this section of rail is 60 mph for passenger trains and 40 mph for freight trains. Total damages were reported as $3,247,355.

Parties to the investigation were Amtrak, BNSF, FRA, BMWED, SMART, BLET, and the Gray County Sheriff's Office.

D. DETAILS OF INVESTIGATION

A camera mounted on the locomotive windshield captured video of laterally displaced rails ahead of the train. Frames from the video were used to estimate the maximum lateral displacement of the rails from their undamaged location.

Figure 1 shows a frame from the locomotive video. Five lines were marked on the video frame. The four yellow lines are placed along the rails, marking the boundaries between the undamaged rails and the ballast and ties. The red line is at the location where the lateral rail displacement of the left rail is largest.

Figure 1. Frame from the Video with Marked Lines Used in Analysis

Estimation of the maximum lateral displacement was based on measuring distances on a printout of Figure 1, on known dimensions of rails, and on known rail gauge. It is assumed that the rail head width is RH=69 mm and the rail base width is RB=140 mm. The rail gauge is RG=1435 mm. Figure 2 is a detail from Figure 1. RL is the left edge of the left rail and RR is the right edge of the left rail. The lateral spacing of RL from RR, dimension B, is the rail base width which is larger than the rail head width.

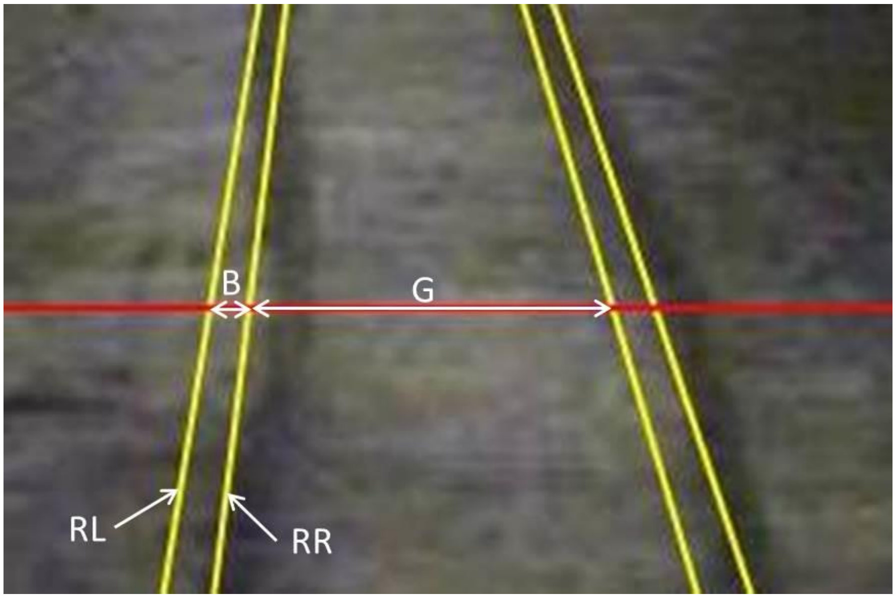

Figure 2. Detail from Figure 1 with Marked Dimensions

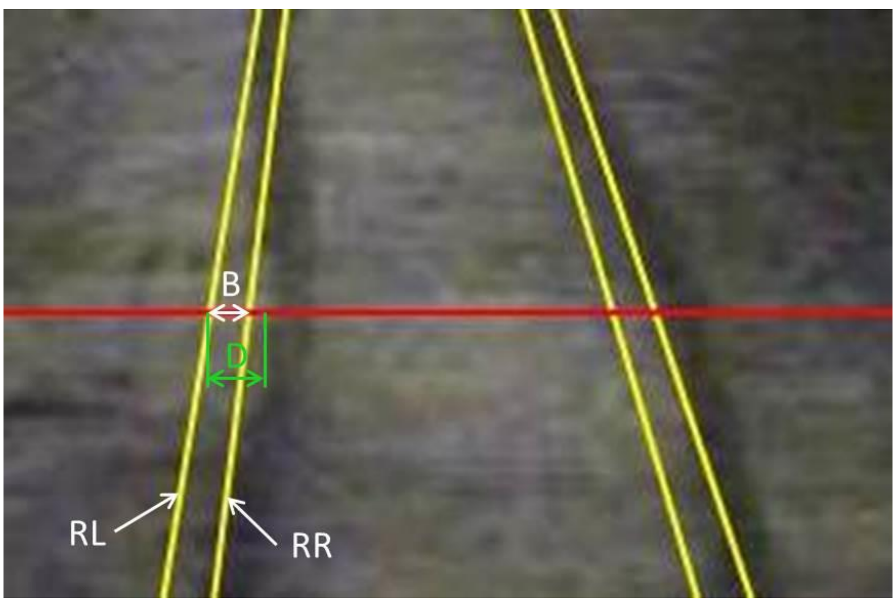

Figure 3. Detail from Figure 1 with Marked Rail Displacement

Dimension G in Figure 2 is related to rail gauge, but is not exactly the rail gauge. G is the rail base to rail base distance rather than the rail head to rail head distance. Therefore, G as shown in Figure 2 corresponds to RG-(RB-RH) on the real track.

The quantities measured on the printout of Figure 1 are B=3.5 mm and G=30 mm. Their ratio is B/G=3.5/30=0.117. This ratio is not exact because low image resolution, poor lighting and shadows make the measurement of B inaccurate.

On the real track, the above ratio corresponds to RB/(RG-(RB-RH))=0.103. The difference between ratio 0.117 on the printout and ratio 0.103 on the real track can be attributed to the inaccuracy of measuring B in Figure 1. To offset this measurement inaccuracy, B is corrected to be $B_c=B\times0.103/0.117=3.5\times0.103/0.117=3.08$ mm, resulting in $B_c/G=0.103$ that matches the real track ratio.

Figure 3 shows a detail from Figure 1 with marked dimensions that were used for estimating the maximum lateral displacement of the left rail. Distance D is from the left edge of the undamaged rail to the left edge of the displaced rail. It is not subject to the same measurement errors as B because it measures the same point before it was displaced and after it was displaced. Therefore, errors due to low image resolution, poor lighting and shadows cancel out.

The displacement D shown in Figure 3 was measured as D=5 mm on the printout of Figure 1. Therefore, the displacement of the real left rail can be computed based on the real rail base RB, the corrected rail base B_c measured in Figure 1, and the displacement D measured in Figure 1 as $RB\times D/B_c=140\times5/3.08=227$ mm=8.9 inches.

To account for error sources neglected up to this point, a tolerance of approximately ±1 inch is assigned to the above nominal displacement estimate. Therefore, the estimated maximum lateral displacement of the left rail is specified as 9±1 inch. The maximum displacement of the right rail looks smaller in Figure 1 than the maximum displacement of the left rail. However, examination of other video frames showed that the maximum displacements of the two rail are approximately equal.

E. CONCLUSIONS

Video captured by a locomotive camera was used to estimate the maximum lateral displacement of rails. It was estimated that the maximum displacement was 9±1 inches.