



C30 The Cause Analysis of a Farm Tractor and Motor Grader Collision Fatality: A Case Study

Kurt D. Weiss, MS, Automotive Safety Research, 5350 Hollister Avenue, Ste D, Santa Barbara, CA 93111-2326*

The goal of this presentation is to share knowledge with the scientific community by thoroughly examining the case information and presenting the details of the collision analysis.

This presentation will impact the the forensic science community by proving case background and demonstrating the analysis used to determine the cause of collision.

A compact 1,900lb utility tractor commonly used in vineyard service was impacted by a 19,500lb motor grader. The tractor operator was ejected and killed. A forensic analysis was performed to determine the cause of the collision.



The incident occurred during the vineyard's canopy maintenance season that includes replacing



Engineering Sciences Section - 2014

the old, non-producing plants as needed. The tractor was following the planting crews while pulling a water storage trailer that allowed the operator to water each new plant by hand. At the end of the row, the tractor entered a service road between the blocks and was completing a U-turn in order to re-enter the block between another pair of rows.

It is unknown if the tractor operator was wearing full-coverage ear protection at the time, though it is unlikely this operator was aware that the grader had previously graded service roads at an adjacent site and was now in transition to another location. The grader's course on the service road intersected that of the tractor while negotiating its U-turn.



A late attempt at collision avoidance was initiated by the grader operator attempting to steer around the tractor. The collision knocked the tractor over onto its left side, and the operator was ejected. Physical evidence shows that the tractor operator was not wearing a lap belt. The grader's left front wheel mounted and rolled over the tractor, then over the operator, causing fatal head injuries. The grader continued down a slight decline for another 140ft after the operator dropped the grading blade as a means to stop the grader whose engine had apparently stalled.



A visibility study was undertaken to determine the sight lines of each operator. The eye-level of the tractor operator was approximately 5.7ft above grade, and the top of the Rollover Protection Structure (ROPS) is 6.5ft above grade. The tractor's orange safety flag rose about another 5-6ft above the ROPS. The vine trellis top wire height adjacent to the tractor's path was approximately 4.8ft, with the top of the vine canopy at about 2.5ft above grade. The eye-level of the grader operator was approximately 8.8ft above grade, and the top of the grader's cab is 11ft above grade. Despite a gentle rise in the service road prior to the point of collision, the grader operator could begin to observe the tractor's orange safety flag approximately 350ft before impact. Therefore, it was concluded that a visibility impairment was not a cause of the collision.

A demonstration video using an exemplar tractor shows the time to complete a U-turn and attain an approximate pre-impact orientation is approximately 6.8 to 7.7sec. In the video, the tractor's flag and



Engineering Sciences Section - 2014

operator's head are clearly visible above the vine canopy height.

Three series of tests were conducted on the subject grader using a Logitech® V-Box II Lite to measure distance, speed, and deceleration. In the first series, the grader's operational speed for each of its six forward gears was determined. The grader's top speed in 5th gear (measured on a level dirt road) was approximately 17.5mph. In the second series, the average deceleration using only the service brake was measured. Pre-braking speeds of 10.7 to 12.4mph (4th gear) yielded average deceleration rates of 0.177 to 0.234g, whereas pre-braking speeds of 16.3 to 17.2mph (5th gear) resulted in average deceleration rates of 0.186 to 0.232g.

A third test series was designed to measure the stopping distance and deceleration rate by only lowering the blade as a means to stop the grader. Three tests conducted at approximately 11mph demonstrated stopping distances of 12.3, 8.5, and 11.8ft, respectively. The average deceleration for these tests was 0.154, 0.148, and 0.176g, respectively. A fourth test conducted at 17.3mph, resulted in a stopping distance of about 23.8ft, with an average deceleration of 0.262g.



A time-position analysis of the grader at 17mph showed it was approximately 14sec from impact when the tractor was reasonably expected to be in view. Assuming a 2sec perception/reaction time, and allowing 2sec for the grading blade to make soil contact, the grader operator could have stopped in about 125ft. Therefore, it was argued that the grader operator had failed to use precious time available to avoid the collision.

Farm Tractor, Motor Grader, Fatality