Project Summary

Impact of heavy vehicles on crossing safety: development of an adapted design tool

This study is part of the **Highway-Railway Grade Crossing Research Program**, an undertaking sponsored by Transport Canada, major Canadian railways, and several provincial authorities. The program is part of Direction 2006, a cooperative initiative with the goal of halving the number of grade crossing and railway trespassing incidents by 2006.

Researchers examined characteristics of heavy vehicles such as braking and acceleration times, the geometry of grade crossings, warning systems, and motor carrier operating regulations. The project developed a mathematical tool for the design and assessment of grade crossings, and made recommendations for amending existing regulations and standards for grade crossing design and safety.

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Photo courtesy of Volvo

Background

Grade crossings are designed using a number of safety parameters intended to give the driver of a heavy vehicle sufficient time to brake to a stop if a train is approaching. Since many jurisdictions require vehicles such as school buses or trucks carrying dangerous goods to stop at a grade crossing before proceeding across, drivers also need to be able to see far enough up the tracks to know they have time to safely accelerate to the other side. This parameter is known as the departure time and is particularly important at passive crossings not equipped with signal lights or gates.

Existing standards require grade crossing designers to establish a sight triangle consisting of a length of road equal to the distance required to brake to a stop plus a margin that takes into account a driver's perception and reaction time. This is known as the stopping sight distance. The second axis of the triangle is composed of a length of track equal to the distance a train is able to cover in the same time plus a margin for the time it takes for a truck to safely clear the tracks.

Existing standards also require a minimum warning of only 20 seconds before the arrival of a train at a grade crossing equipped with signal equipment. In the case of a passive crossing, the standard requires that a driver be able to see the train only 10 seconds before it crosses the road.

Objectives

This study examined characteristics of heavy vehicles such as buses and trucks, driver behaviour, regulations, warning systems, and grade crossing geometry to develop improved methods of calculating warning times and stopping distances, and to make recommendations for changes to existing standards and operating regulations.

Findings

A variety of heavy vehicles (buses, trucks and tractor-trailers) were tested to measure their acceleration times and braking distances. The tests were conducted on the test tracks at the Centre de formation en transport routier of the Rivière du Nord school board and at PMG Technologies Inc. in Blainville, Quebec, on eight grade crossings located between St. Thérèse, Quebec, and St. Jérôme, Quebec, and at a ninth crossing in a logging area near La Tuque, Quebec.

Criteria used to select the vehicles to be studied included engine horsepower, transmission ratio, number of axles, and gross weight of vehicles. The vehicles were loaded to their full legal capacity in order to assess their worst performances. The Racelogic Velocity Box, which

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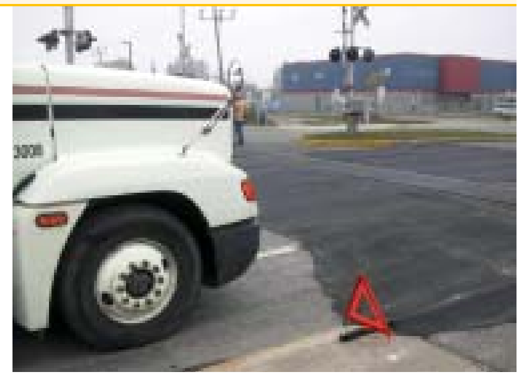
features GPS technology, was used as the data acquisition system for all tests. Tests included:

- acceleration tests over a maximum of 125 m on flat, dry, asphalt roads, and over a maximum of 55 m on gravel roads
- braking tests at 90 km/h on wet asphalt roads
- acceleration tests from the stop line to the clearance point of eight typical crossing configurations



Evaluations were also conducted using a logging truck on a typical logging road (with oversized loads) and using a highway motor coach on a braking test track.

The results were then used to validate a mathematical model of heavy vehicle acceleration. This model and the results of the various tests, including the braking tests and site tests at railway crossings, were then used to develop a railway crossing design and assessment tool that could be integrated into a new regulatory standard under development by Transport Canada.

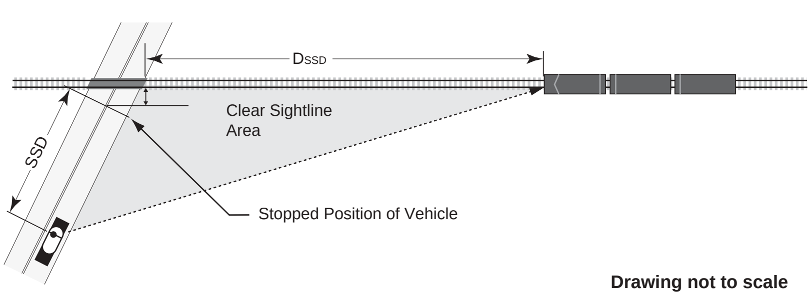
The first part of the tool consists of reference graphs of departure times that depend on the road profile, design vehicle chosen, crossing clearance distance and road condition, or prohibition from changing gears. Methods for using the reference graphs are also proposed for tanker trucks, for grade crossings near a road intersection, and for grade crossings with poor surface conditions. The second part of the tool consists of tables that give the stopping sight distances for vehicles with and without ABS brakes, according to the road profile and the legal speed limit.

These tools make it possible to determine sight triangles that are adapted for commercial vehicles of all weights and sizes, for all operating criteria, road conditions, and truck and train speeds, and for normal weather conditions. In addition, the results make it possible to calculate the warning time and gate descent time for active crossings.

Researchers also conducted interviews with nearly 100 truck drivers. While most (73 percent) reported that they treated grade crossings the same as road intersections, a significant percentage (24 percent) reported that they regularly slowed as they approached a crossing. While this may appear to be a safe behaviour, grade crossings are in fact designed to be approached at the speed limit. This deceleration is not included in the calculation of the stopping sight distance, underscoring the need for including a safety margin in calculating crossing and warning times.

Minimum Sightlines - Grade Crossings without a Grade Crossing Warning System

Minimum Sightlines for Drivers Approaching a Grade Crossing



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Only 62 percent of drivers said they habitually checked visually for an approaching train, suggesting a need for greater awareness and training about crossing safety.

Conclusion

The results show that the crossing times currently used to design grade crossings are too short, particularly for multi-track grade crossings and for long heavy vehicles. The researchers conclude that it is preferable to adapt the warning systems to each site using the reference graphs and tables developed in the project.

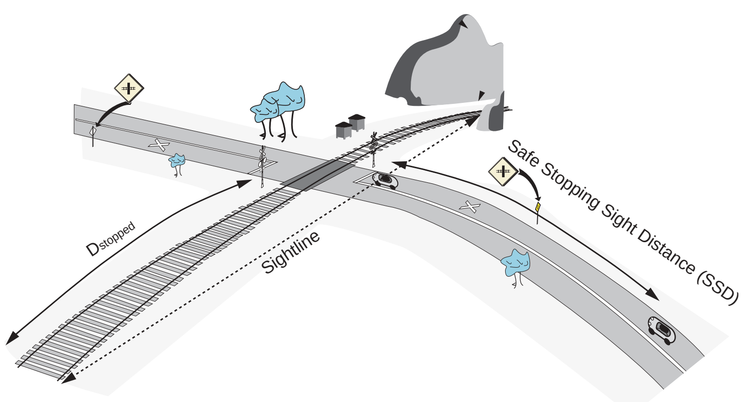
The researchers also found that provincial regulations prohibiting drivers from changing gears when crossing railway tracks increase the crossing time for heavy vehicles. Although the rule was justified in the past by the unreliability of transmissions and axles and the fact that trucks could cross railway tracks more quickly without changing gears, this is no longer the case for today's vehicles.

Recommendations

The report's recommendations include:

- Integrate the tool into the new regulatory standard.
- Fixed crossing times in the existing standard should be removed.
- Various regulations prohibiting drivers of heavy vehicles from changing gears when crossing railway tracks should be abolished.

Minimum Sightlines - Grade Crossings with a Grade Crossing Warning System



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