

Reduction of Speed Limit at Approaches to Railway Level Crossings in WA

Radalj T¹, Kidd B¹ and Sultana S¹
¹Main Roads WA

Presenter - Brian Kidd

Abstract

A speed limit reduction study has been undertaken to assess effectiveness of lower speed limits on driver speed behaviour at the approaches to railway level crossings on high speed roads in WA. The sample consisted of 7 railway crossings of which 2 were controlled by boom barriers and 5 by flashlights on 110 km/h roads.

The proposed trial involves the reduction of the speed limit from 110 km/h to 80 km/h over 600m around each crossing. The speed measurements were taken at 5 locations in the vicinity of the crossings, at open road sections approximately 1 km from the crossing, at the approach to the railway level crossing warning signage, and at the crossing itself.

The analysis of baseline speed data demonstrated some noticeable relative differences in mean speeds between the observation points. The difference in the mean speed at an open road section and the mean speed at the crossing was estimated at 7 km/h, 104 and 97 km/h, respectively. Correspondingly, the non-compliance over the observed road section sections ranged between 27% on the open road section and 13% at the crossing. Likewise, proportions of vehicles travelling 10 or more km/h above the speed limit were approximately 5% at open road section and 2% at the crossing.

From the observed differences in vehicle speed indices between the three locations at the approaching road section it can be inferred that on average drivers do change their travel speeds as a result of perceived hazard associated with the railway level crossing. However, if the magnitudes in the differences in speed indices significantly changed after the reduction in the speed limit to 80 km/h it can be inferred that the driver alertness to the hazard had improved, not only due to the railway level crossing signage but to the compliance to the reduced speed limit at the approach to and exit from the railway level crossing, and therefore the risk of colliding with the oncoming train would also be significantly decreased.

Keywords Railway level crossings, speed limits, driver behaviour

1. INTRODUCTION

Safety at railway level crossings has been of concern in all Australian States and Territories and has received a special attention in recent years, mainly because of the far severe outcomes in a case of crash incidence between vehicles and the trains compared to the severity outcomes resulting from vehicle collisions not involving trains. Although the occurrence of such incidents are rare but when they do occur they result in enormous publicity and public disapproval of road and rail safety authorities and their undertakings in improvement of safety at railway level crossings.

In Western Australia, over the period between 1995 and 2010 there have been 102 crashes at the railway level crossings involving trains and motorised vehicles, of which 35% in the Perth metropolitan area and 65% in rural areas. An examination of the trends in number of crashes for the study period suggests there is a significant decline in the number of crashes over the above mentioned period in both, the Perth metropolitan and rural areas (see Figure 1).

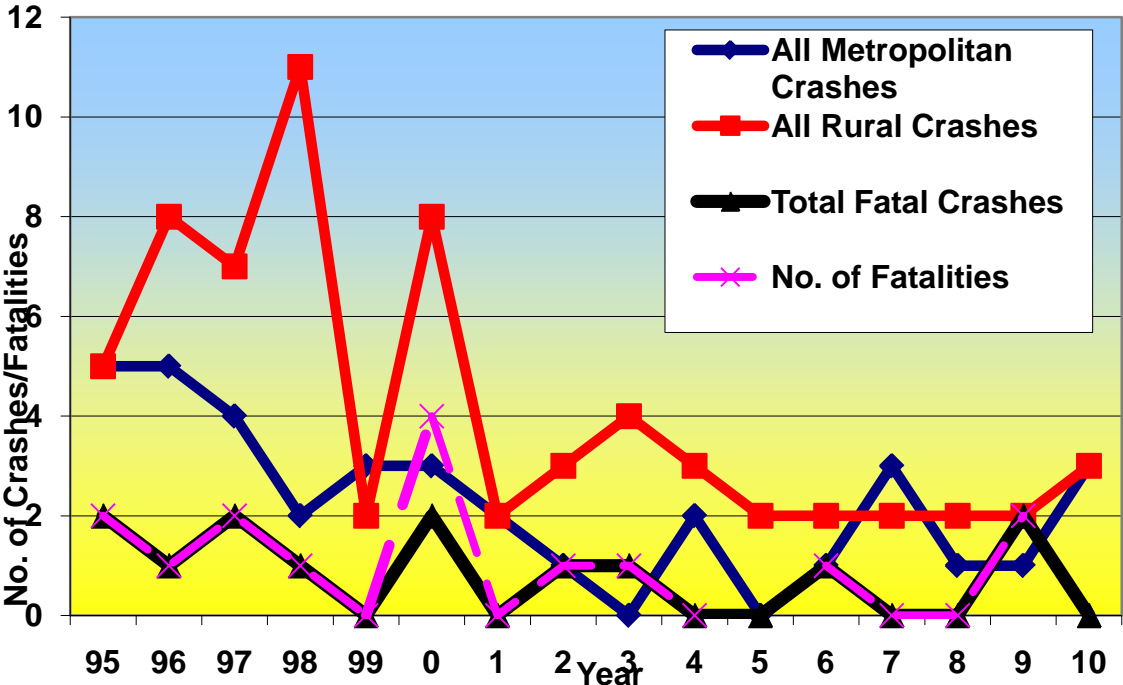


Figure 1. Distribution of number of crashes at the railway level crossings involving trains by year, Western Australia

The number of crashes in the rural areas, although small in number, is unacceptable due to the number of fatal crashes that occurred over the observation period. The rural areas railway level crossings experienced twice as many fatal crashes than the Perth metropolitan area (9 vs. 4 fatal crashes). Similarly, 2.8 times more of all other types of severity crashes occurred in the rural areas than in the Perth metropolitan area.

The nature of the railway level crossing is such that it provides rare opportunities for conflicts between vehicles and trains; however, if the conflict does occur then it results in a crash of serious nature. Despite relatively strong control of the crossings by active devices, sixty five percent of the Western Australian vehicle-train crashes occurred at the crossings controlled by the active devices such as boom gates or flashing lights, accounting for 69% of all fatal crashes, 54% accounted for by “Flashing Lights” and 15% by “Boom Gates”. These controls account for 70% of all casualty crashes at the railway level crossings, approximately twice as many at the crossings protected by “Flashing Lights” than the crossings protected by “Boom Gates”. Since, in general case, the roads at which crossings are protected by “Boom Gates” carry significantly larger amount of traffic than the roads at which the crossings are protected by “Flashing Lights” the road safety statistics presented above points out to the significantly higher risk of crashes with trains at the crossing protected by “Flashing Lights” than the crossings protected by “Boom Gates” when the traffic volume is controlled for.

The remainder of the crashes occurred at the passively controlled crossings. Passive railway level crossings are defined as crossings that are controlled by the regulatory signs such as “Give Way” or “Stop” signs, supported by warning signs.

The casualty crashes over the 16-year period, between 1995 and 2010, accounted for 15 deaths, 17 serious injuries and 23 persons requiring medical treatment. Approximately, 27% of the train crashes resulted in a fatality and a serious injury. The majority of the fatal crashes, 7 out of 13, occurred at the railway level crossings controlled by flashing lights. The crash fatality rate for rural area was slightly higher than in the Perth metropolitan area, 14% compared to 11%. Crash fatality rate at railway level crossings controlled by flashing lights was 18% compared to the rate of 7% at the crossings protected by boom gates.

The data suggests very little association between the crashes at the railway level crossings and contributory factors such as alcohol. Alcohol could be attributed to only 10% of the crashes and 90% could be attributed to vehicle driver errors, fatigue, speed or risk taking due to low frequency of trains.

The statistics indicates that the risk of an injury in a crash involving train is very high, up to 50%, for every crash that occurs, compared to 20% of all recorded crashes involving vehicles only. For more severe crashes such as fatal crashes, the average risk for crashes involving trains is approximately 30 times higher than for other types of crashes involving motorised vehicles. The risk could be as high as 50 times greater for the 110 km/h high-speed open roads. Although the probability of a crash at a railway level crossing is very small compared to a crash involving other vehicles, the severity of the crashes involving trains (when they do occur) is extremely large and when a crash occurs, media coverage of the event is quite extensive and critical of road authority standards and practices, particularly when the crashes occur at the passively controlled crossings, or crossings controlled by “Flashing Lights”.

At least 20% of all railway level crossing crashes and 40% of all fatal crashes occurred on the 110 km/h speed limit roads. These statistics suggest that a reduction in the approach speed to the railway level crossings from 110 km/h to say 80 km/h would significantly reduce the risk of a crash with a train and its severity, especially the risk of a fatal crash. It is hypothesised that a reduction in the speed limit from 110 km/h to 80 km/h would result in the substantial reduction of travel speed of most of the vehicles at the approaches to the railway level crossing, and consequently a significant increase in driver alertness to the hazard. It is also quite likely that the regulatory speed signs will increase driver alertness to the hazardous characteristics of the railway level crossings associated with possible passages of the trains.

The presence of the additional sign at the approach to the crossing, apart from its regulatory reduced speed limit effect on the travel speed, is in itself expected to add some contribution to the overall effect on driver perception of the hazardous environment in addition what has already been provided by the railway level crossing signs.

The results of the proposed study are expected to provide insights into effectiveness of the speed limit reduction on driver travel speeds at the approaches to the crossings. The proposed trial will be conducted on a small sample size of locations, which are considered to provide sufficient number of vehicle speed measurements to assess effectiveness of the lower speed limits on the driver speed behaviours. Pending the results of this study general adoption of 80 km/h speed limits at all high speed public road level crossings would follow.

2. STUDY DESIGN AND METHODOLOGY

A sample of seven railway level crossings located on 110 km/h rural roads were selected to trial the reduction of the speed limit at the approaches to the crossings, from 110 km/h to 80 km/h. The objective of the study is to use the differential vehicle travel speed indices before and after the speed limit reduction in investigating feasibility of developing speed limit reduction strategies for railway level crossings across the entire high speed road network, especially those with active protection such as flashing lights and boom gates on 110 km/h roads. These types of crossings are mainly located in rural areas, characterised by relatively low traffic volumes.

2.1 Sample

The sample consisted of seven railway level crossings, five of which are controlled by flashing lights and two controlled by boom gates. The boom gate controlled crossings are on National and State highways, and of the other five crossings controlled by flashing lights four are on Main Roads and one on a local road.

Figure 2 below shows a typical crossing.



Figure 2 Railway level crossings on Goomalling Merredin Road

Five of the crossings were situated in 110 km/h speed zones for a considerable distance on either approach to the crossings, while two of the crossings while in 110km/h zones were relatively close to 80km/h buffer speed zones near rural town sites. For those two sides of these crossings near town sites, it is proposed that the 80km/h speed zone at the town site will extend across to the crossings. While this longer 80km/h zone may meet with local opposition, as a common occurrence across the network it was felt that this situation should be included in the trial.

2.2 Study Design

The proposed change in the speed limit at the approaches/exits from the rail crossings to 80 km/h is expected to change driver speed behaviours in that the travel speed through the 80 km/h zone will be reduced by the majority of the drivers. The reduction of the travel speed is likely to be exercised by the drivers within the zone, with possibly highest reduction in the close vicinity to the crossing from the approach side. If significant reduction is achieved then it can be inferred that drivers had increased level of alertness at the approach to the crossing, and their perception of the risk was increased in comparison to the risk level they perceived prior to the speed limit reduction. In order to assess the effect of the speed limit reduction from 110 km/h to 80 km/h, a before-after design was proposed for the evaluation of the effect. The effect will be measured by the change in magnitude of the average speed and the proportion of drivers in various speed groups determined by the vehicle speeds collected before and after the speed limit change.

The vehicle speed measurements will be taken at five locations along approximately two kilometre sections of road, + or – 1 km from the crossing, as illustrated below.



The +/- approx. 1000m speed measurement sites are located at open road sections, quite far away from the rail crossing and signage associated with the crossing that might have an effect on driver speed behaviours. The +/- approx. 200m vehicle speed measurement sites are located in the vicinity of the rail crossing signage at the approaches to the crossing, approximately at the distances at which the proposed 80 km/h signs will be installed. The travel speeds of vehicles are measured in both directions at all four sites, approach to and exist from the crossing. The fifth data collection site was located at the rail crossing itself in the proximity of the “STOP” line, from each side of the crossing, where approach and exit vehicle speeds were recorded.

The 80 km/h speed limit signs were erected at the distance of around 300 m from each of the crossings. The choice of the distance of 300 m is based on the standard practice for placement of 80 km/h speed limit signs at approaches to traffic lights controlled intersections on high speed roads.

It is anticipated that no additional enforcement above ‘normal’ enforcement will be conducted during the trial, that is, during the period between the installation of speed limit signs and the completion of the “after” survey. The change in the speed limit is expected to have the same effect on driver speed behaviours as any other speed limit at the road network with respect to the speed limit compliance.

It is expected that the “after” survey vehicle speed data will be significantly reduced in comparison to the speeds observed in the “before” survey. The most changes in vehicle speeds are expected to be recorded in the vicinity of the “STOP” line just before the crossing zone. Research shows that a percentage of drivers comply with speed limit signs, however, it was shown that there is a greater compliance with limits that more closely reflect the speed that the majority of drivers believe is safe for the prevailing conditions. In addition, speed enforcement on a regular basis ensures a higher level of compliance.

The introduction of the reduced speed limit of 80 km/h at the approaches to the crossings is expected to change the drivers speed behaviours without extensive Police enforcement. If the reduction in the travel speed is achieved by the reduction in the speed limit then it can be

considered that the objectives are fulfilled, in which case the introduction of the reduced speed limits at the railway level crossings at the high speed roads may be justified.

If the results of the trial demonstrate significant changes in driver speed behaviours then it would be recommended that all railway level crossings in the state be considered for speed limit reductions to 80 km/h where open road speed limit is 110 km/h and the railway level crossings are protected by boom gates or flashing lights. It is anticipated that the outcome of the study could be used as a basis for the National strategy in implementing reduced speed limits at the approaches to the railway level crossings.

3. ANALYSIS

The “before” speed surveys were conducted over the period October 2008 and March 2010. As the 80 km/h speed zones were only installed in June 2011, the ‘after’ results will not be available until August 2011.

3.1 Analysis for the Sample

If it is assumed that the road environments surrounding the railway level crossings in the sample were similar and that the driver speed behaviours at the crossings were not significantly different neither between the crossings in the sample nor the points on the road sections where the speed measurements were taken, then it would be quite valid to combine the speed data collected at the seven railway level crossings and estimate speed indices at various points at the approaches to the crossing.

In order to preserve homogeneity of speed limits for the road sections within which the crossings are located all survey points within the road sections with the lower approach speed limits than 110 km/h were excluded from the analysis. The data presented in Figure 3 shows the distribution of mean approach speeds at the three points representing driver speed behaviours: at the open road section, the section when first railway signs were encountered and at the crossing itself just before they travel over the crossing in the vicinity of the “STOP” line at the remaining 5 crossings.

The data collected at the three approach points demonstrate a gradual vehicle speed reductions, from 103.8 km/h to 97.0, a reduction of approximately 7 km/h. It could be inferred that drivers react to the changes in road environment, particularly related to the railway level signage, at the approaches to the railway level crossings as a recognition of a possible hazard associated with the possible arrival of a train and activation of flashing lights or boom gates. This is especially demonstrated by the mean speed at the second approach point in the vicinity of the warning signs. The reduction in the mean speed recorded at the crossing itself may not entirely be attributed to the actual speed reduction resulting from voluntary driver actions; rather it could be partly associated with the activation of the controls at the crossing due to train arrivals. It is anticipated that these changes will be more pronounced after the changes in the speed limit to 80 km/h, demonstrated by the larger gradient for the changes in the mean speeds from the second point to the point at the crossing. This hypothesis could only be true under assumption that frequency of trains passing through the crossings is not significantly different between the before and after surveys.

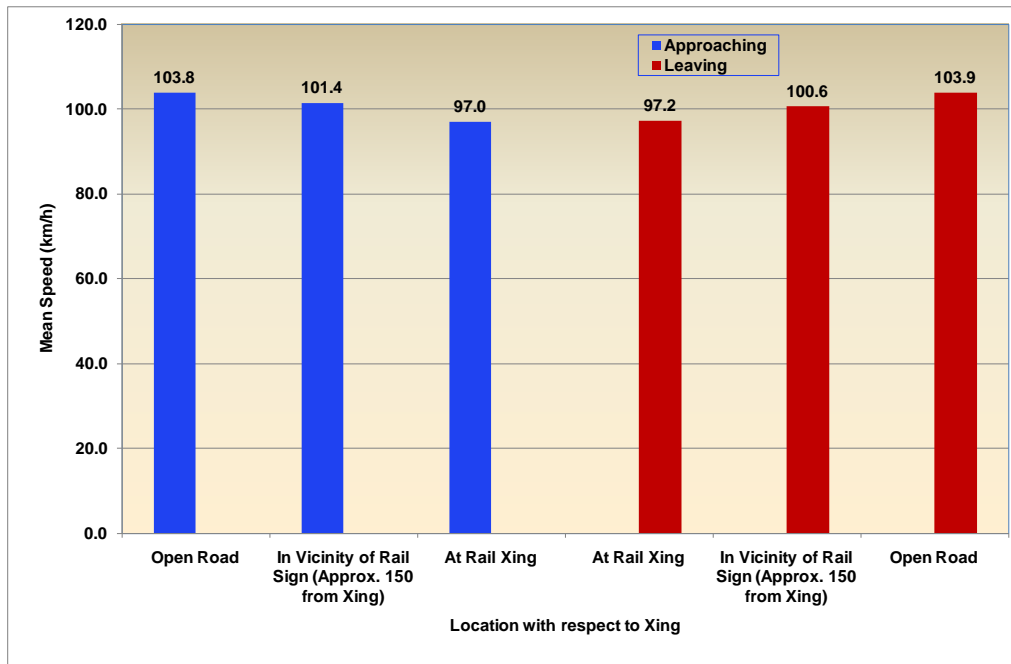


Figure 3. Mean vehicle speeds at some locations when approaching to and leaving from the railway level crossings on 110 km/h rural roads, WA

The speed data collected at the exit points from the crossing show that vehicles when passing over the crossing accelerate to reach approximately similar mean speeds as the mean approach speeds at the corresponding points on the other side of the crossing.

From the analysis of the “before” speed data it can be inferred that, on average, drivers are alerted to the hazards associated with the railway level crossing. It seems that an average driver reduces his travel speeds to a most likely acceptable and manageable speed level that provides adequate conditions for safe passage through the crossing or eventual stopping due to activation of the signals before arrivals of the train. It is expected that the “after” data would show increased alertness of the drivers indicated by larger decreases in the mean speeds at the speed measurement points within the speed limit section of 80 km/h.

3.2 Speed compliance at the reference points with respect to the crossings

The analysis of the vehicle speeds shows that absolute driver compliance to the speed limit of 110 km/h varies between the points and the directions. The non-compliance rate of the approaching vehicles ranges from 26% at the open road section to 13% at the crossing itself, the decrease in non-compliance of 13%. The non-compliance rate at the exit side of the crossing increases from approximately 13% just after the crossing to 27% at the open road section 1 km or more upstream from the crossing, similar to the non-compliance recorded at the corresponding approach points (see Figure 4).

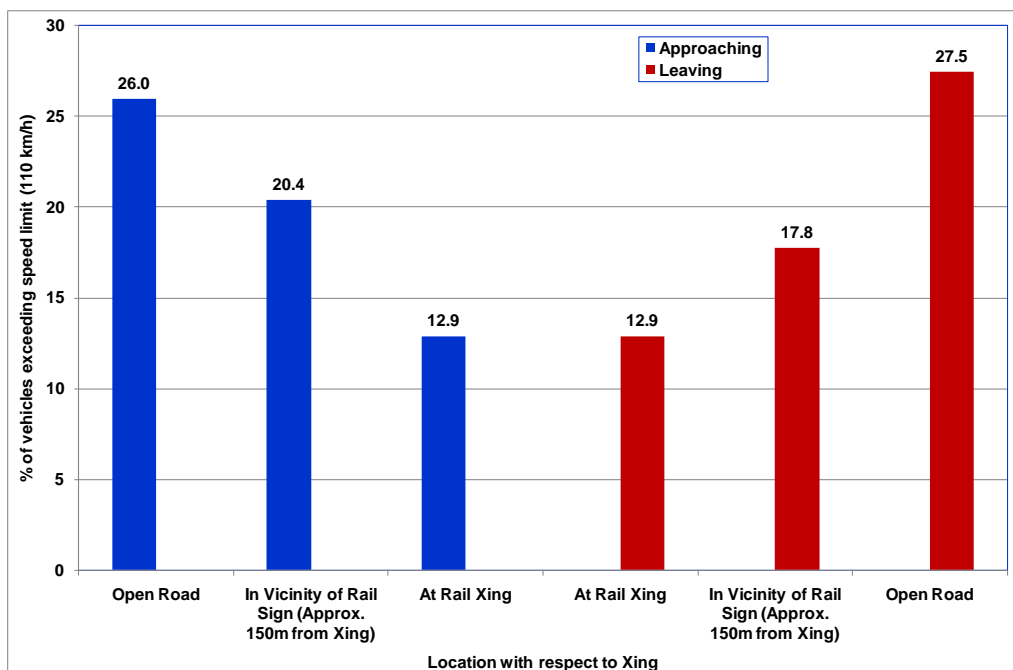


Figure 4. Percentage of vehicles exceeding the speed limit at various locations at the approach to and exit from the railway level crossing

Correspondingly, a small percentage of drivers were travelling at excessive speeds, 10 or more km/h above the speed limit, along the observed road sections, ranging from 5% at open road sections to 2% over the crossing (see Figure 5). Due to passage of trains some of the vehicles in the samples are not travelling in the “free traffic flowing” environments, which in turn to some extent effected overall true compliance rate, resulting in a bias towards lower than the true compliance rates at the two points in the vicinity of the crossing; i.e. at the crossing itself and the point approximately 150 m from the crossing.

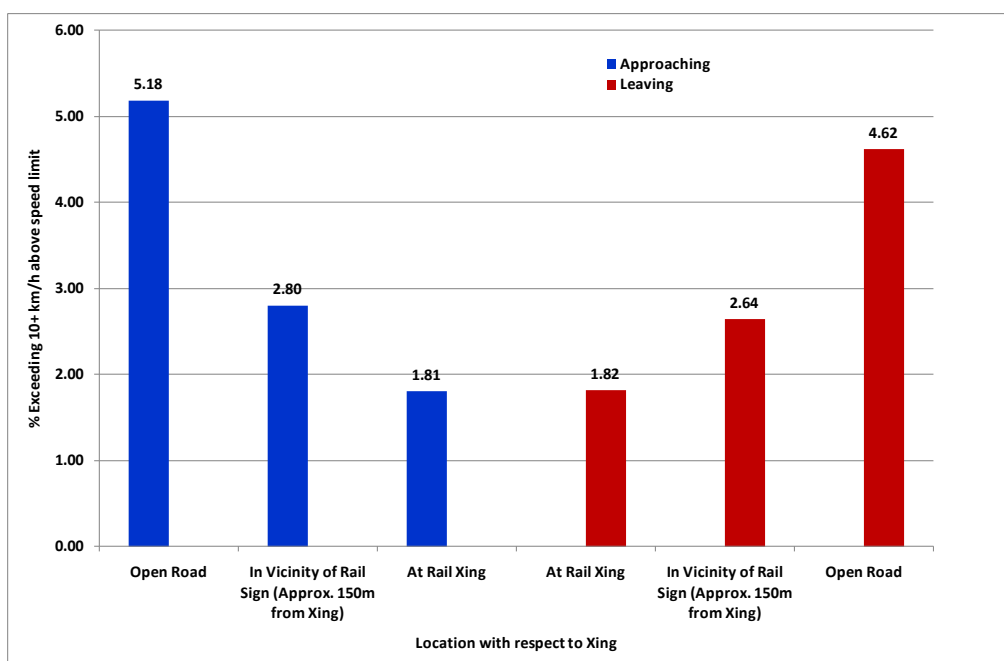


Figure 5. Percentage of vehicles exceeding 10 km/h above the speed limit at various locations at the approach to and exit from the railway level crossing

The compliance rate Distribution of vehicle speeds by speed bins and at the observed locations is presented in Figure 6, below. The most prevalent speed bin was 100 to 110 km/h, 40% at open road section to 34% at the crossing, followed by the 90 to 100 km/h bin. The closer the points are to the crossing the larger the spread of the vehicle speeds are at those points. Overall, in general case, as the vehicles approach the crossing their travel speeds are reduced to some magnitude perceived by driver as safe speed for the railway level crossing environment. From the derived speed indices it can be inferred that drivers perceive the railway level crossing environment as a hazardous environment by travelling at speeds below the posted speed limit of 110 km/h. Only 12% of drivers exceed the speed limit of 110 km/h.

Although the travel speed for some drivers is above the speed limit, the speed differential between the crossing points and the other approach points could well be quite similar to the speed differentials for other vehicles whose travel speeds are below the speed limit, in which case similar inferences could be made on driver awareness of these vehicles related to the hazardousness associated with possible conflicts with oncoming trains at the crossing. If the vehicles travelled at some excessive speeds above the speed limit at a particular measurement point in the crossing sample of points but speed differential between the points is similar to the speed differential of other vehicles that did not exceed the speed limit it can be concluded that the drivers were alerted by the crossing environment to be cautious during the approach and passage over the crossing although it might not be the most acceptable behaviour in such hazardous environment. This hypothesis was not tested in this study due to difficulties in selecting and “following” the vehicles along the observed road section, from the point on the open road section to the point at the crossing.

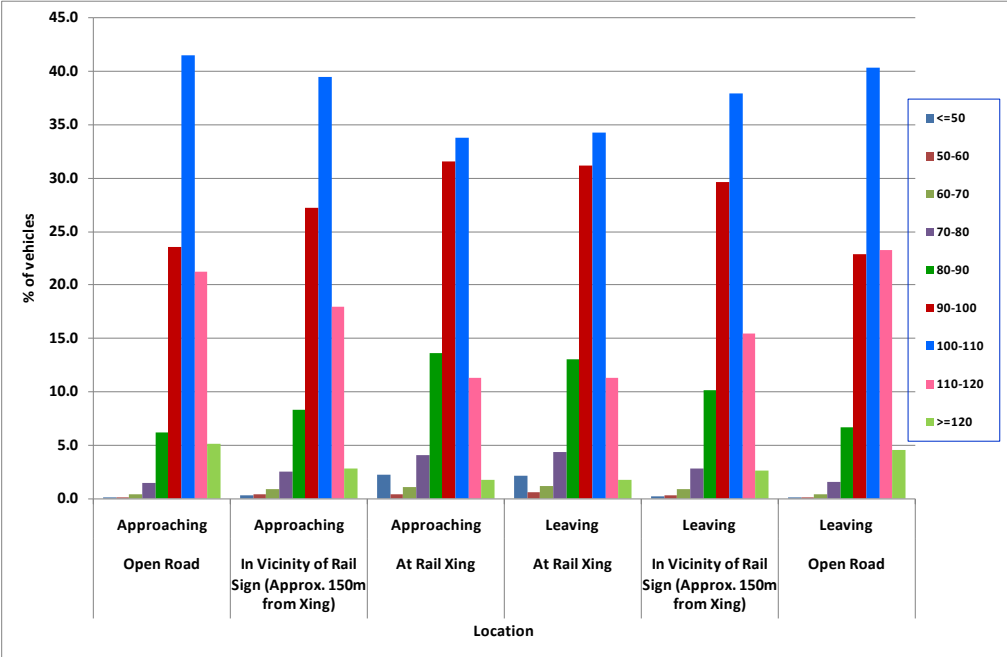


Figure 6. Distribution of vehicle speeds at various locations at the approach to and exit from the railway level crossing on 110 km/h road section

4. CONCLUSIONS AND RECOMMENDATIONS

No available research could be found on the assessment of the benefits of installing reduced speed limits at the approaches to the railway level crossings protected by flashing lights or boom gates on arterial high speed roads such as 110 km/h speed limit rural roads. It could be hypothesised that the reduction in travel speed approaching the crossings could be achieved by the reduction in the speed limit over the reasonable length of road section, approximately 300 m on each side of the crossing.

If a reasonable reduction in the travel speed was achieved by speed limit reduction in comparison to the current railway level crossing approach travel speed reductions on the high speed roads attributed to the railway level crossing warning signs then it can be inferred that the speed limit reduction resulted in a reduction in overall risk either related to collision with a train or severity of such incidence. The reduction in the travel speed indices may not directly result in the increase in driver alertness to the oncoming hazard associated with the crossing due to driver perceived “safe” travel speeds relative to the speed limit; however, the reduced travel speeds that resulted from the reduction in the speed limit would increase travel time within the lower speed limit section which in turn would most likely result in higher probability of increase in driver alertness and improved perception of possible hazards at the approach to the crossing.

If the “after” vehicle speeds data demonstrates a significant reduction in the speed indices over the approaching road section, even if the gradient for speed reduction indices between the three observation points remains the same, then the reduction of the speed limit from 110 km/ to the proposed speed limit of 80 km/h may be justified.

Although the “before” speed survey showed that an average driver does change his speed behaviours over the length of the road sections from the open high speed road section to the encountered railway level crossing signs, and further downstream to the crossing itself, as an indication of increased caution, the reduced speed limit may result in further reduction in the mean speed indices at various points along the road section. Most importantly the reduction in the travel speeds would decrease likelihood of a vehicle collision with oncoming trains due to extended time for reaction to the hazard and signage along the approach to the crossing, and consequently undertake appropriate action to avoid such hazards.

The objective of this study is to assess possible justification for implementation of the strategy that may be formulated for speed limit reduction at the railway level crossings on high speed open roads controlled by flashing lights or boom gates. If the results of this trial demonstrate a substantial benefits in terms of travel speed reduction at the approaches to the crossings, and therefore increase in driver alertness to the hazards, the treatment itself would be characterised by a high benefit/cost ratio due to low implementation cost and potentially high reduction in the risk of running red lights or colliding with a train.