Characteristics of Railway-Roadway Level Crossings at Coastal Railway Line in Sri Lanka

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Abstract— *Rail transportation is a safe, efficient, continuously operating sustainable transportation mode, in all-weather conditions, and light conditions. Along with these advantages, the role of rail transport has become increasingly important. Therefore, it is important to investigate the characteristics of the railway-roadway level crossings in Sri Lanka. Railway-roadway level crossings at coastal railway line from Aluthgama to Ambalangoda were visited to collect the roadway, railway, traffic, environmental, and crash data. Out of 51 crossings that observed in this study, about 94.1% of railway-roadway level crossings were facilitated with active safety measures. About 7.0% of railway-roadway level crossings were without gates and among them 33.3% of crossings were facilitated with passive safety measures and other crossings were under unsafe conditions. Several problems related to railway-roadway level crossing were identified. The collected data could be utilized to develop various statistical models for identifying relationships between the number of crashes and level crossing characteristics. It could be used to identify potential high-crash prone railway-roadway crossings and key factors which increase the number of crashes.*

Keywords— **Railway crossing safety, Level crossing features, Level crossing crashes**

I. INTRODUCTION

Rail transportation is a safe, efficient, continuously operating sustainable transportation mode, in all-weather conditions, and light conditions. Along with these advantages, the role of rail transport has become increasingly important. Railroads are one of the modes that could be used to the movement of people and movement of freight during the journey from origin to destination. The traffic safety is a primary concern globally due to its magnitude of social and economic impact. Railway-roadway level crossings are crucial locations for transportation safety and efficiency in a ground transportation network. Railway-roadway level crossings are train–roadway vehicle crash-prone areas due to potential points of conflict between roadway traffic and trains as shown in Figure 1. Because of the substantial mass difference between train and roadway vehicle, the train–motor vehicle crash severity can be much higher than those of other types of traffic crashes.

Figure 1. A Railway-roadway Level Crossing

The Sri Lanka Railway (SLR) network comprises nine lines radiating from Colombo, which connect the most major population and industrial centers. Today SLR functions with almost 310 trains and facilitates about 0.34 million passengers daily (SLR, 2017). According to the SLR, its network covers 1960 Km with a 5’ 6” broad gauges and approximately 1186 level crossings can be observed in the country. SLR divided level crossings into three categories: protected level crossings, unprotected level crossings, and private level crossings. Protected level crossings can be further divided into four categories as follows.

1. Farm gates – This crossing is protected by gates, on both sides of the railway, which is completed with the farm type gate, when closed across the railway track.

2. Mechanically operated level crossings- These level crossings can be seen across the roads which having heavy traffic density and progressively interlocked with signals and plan to operate by gatemen.

3. Automatic Bell and Light - These crossings have no barriers but which are protected by road traffic light signals and audible warnings are provided for pedestrians without gatemen.

4. Electrically operated barrier - These crossings are protected by road traffic by light signals and a lifting barrier on the near side of the roadway on both sides of the railway. Audible warnings to pedestrians are also provided by the gatemen.

Unprotected level crossings are provided for some minor road- and path-crossings the railway line which are

operated by police or railway staff. These level crossings are provided by all warning signals for pedestrians. These level crossings are also called bamboo gate level crossings. Private level crossings are provided as passage across the railway track for the sole use of the private owners of land whose right of a way or passage may have been intersected at the time of construction of the railway. These level crossings are padlocked by the owners.

The numbers of crashes at railway-roadway level crossings in Sri Lanka are increasing annually. In 2011, 2010, 2009, and 2008 numbers of crashes were 82, 75, 66, and 43 respectively (Mudugamuwa, 2012). Crashes at railway-roadway level crossings pose a serious problem throughout Sri Lanka as they account for a significant loss of lives. Therefore, it is important to investigate the characteristics of the railway-roadway level crossings in Sri Lanka while identifying the relationships between crossing crashes and features of crossings. Such results can be used to recommend better crash mitigation strategies, thereby improving the safety at the level crossings.

II. METHODOLOGY

Field surveys on railway-roadway level crossings were made at coastal railway line from Aluthgama to Ambalangoda to collect the roadway, railway, traffic, and environmental-related data. The location of the crossings, geometry, type of the gates, gate operator availability, warning signs availability, light signals availability, other traffic management system existence, safety precautions taken by the SLR, number of railway tracks, visibility issues, gradient of that roads, number of roadway lanes, angle of crossing, speed limit of trains and other related details were collected during the field surveys. Also, data on the daily number of trains, maximum allowable rail speed, and the roadway Average Annual Daily Traffic (AADT) were collected. The crash data from year 2009 to 2014 were obtained from the Police.

III. RESULTS

Out of 51 crossings that were observed in this study, about 94.1% of railway-roadway level crossings were facilitated with active safety measures. About 7.0% of railway-roadway level crossings were without gates and among them 33.3% of crossings were facilitated with passive safety measures and other crossings were under unsafe conditions. If considering the crossing at C-class or D-class roadways in the study area, all the gates were operated by gate operators manually. A few factors which could be used to improve the railway-roadway crossing safety were identified. When considering the grade separation of roadway and railway at the crossing, about 52.9% of railway-roadway level crossings were having more than one meter sudden height difference and about 5.9% of crossings exceeded the two meter height of grade separation which can be a comfort reduction factor for the roadway users. Field observations also showed that some of the warning signs and the safety sign boards were fixed very close to the railway-roadway level crossings without considering the perception reaction time of the vehicles and this can be very dangerous in crossings with unsafe gates.

Table 1 shows the crash data collected from the Elpitiya police station and that were cross checked with the police crash database. When looking at the variation of crash data, it was obvious that after 2012, the number of crashes at the crossings from Aluthgama to Ambalangoda has been reduced. This may be due to the implementation of new gates for some unprotected railway-roadway crossings at that time.

Table 1. Crossing Crashes from Aluthgama to Ambalngoda

Crash Category	Year					
	2009	2010	2011	2012	2013	2014
Fatal	0	2	3	2	0	0
Injury	1	0	1	0	0	0
Property damage only	2	0	0	1	1	0
Total	3	2	4	3	1	0

IV. CONCLUSIONS

The observed grade separations at the railway-roadway crossings need to be corrected by doing proper vertical alignments. Also, it is recommended to relocate the closely located sign boards at proper distances and those are needed to be properly visible for the riders during the night time. Using the collected data, various statistical models could be considered for identifying relationships between number of crashes and level crossing characteristics. Because of the random and discrete nature of crashes, Poisson regression is a good starting point for modeling. Crash prediction model for a railway-roadway level crossing is intended to predict the likelihood of a crash occurring over a given period of time, and given conditions at the crossing. It is also used to identify potential high-crash prone locations and key factors which increase the number of crashes. These analyses may be crucial for traffic safety evaluation and management programs because this can be used to examine the performance of existing transportation infrastructure and purpose countermeasures to improve the safety.

ACKNOWLEDGMENT

Authors would like to acknowledge the Sri Lanka Police for providing the crash data and for Randhula Gunawardhana for her help.

REFERENCES

Mudugama, M. (2012). Mishaps at Unprotected Level Crossings Increase, The Island, Colombo.

Sri Lanka Railways, http://www.railway.gov.lk, Accessed on 25th July 2017.