A STUDY ON RAILWAY-ROADWAY LEVEL CROSSING SAFETY

Kulasingham Ragulan, Niranga Amarasingha
Department of Civil Engineering, Faculty of Engineering,
Sri Lanka Institute of Information Technology, Malabe, Sri Lanka.
ragulan1993@gmail.com, *niranga.a@sliit.lk*

ABSTRACT - The railway-roadway Level Crossing (LC) safety was studied as a significant number of rail crashes are being reported at LCs in Sri Lanka. Four years of railway crash data, LCs characteristics, rail line characteristics, and highway characteristics were collected at railways from Colombo to Polgahawela. It has succeeded in identifying the LCs which had shortcomings such as no barriers, prolonged bell sound, employment of elderly workers in unprotected LCs without basic facilities or assured wages, and view of approaching train being blocked by high rise buildings and trees. Multiple linear regression analyses were done by considering two independent variables at a time. Possible solutions were recommended taking into consideration of the modern methods used in this field.

Keywords: Level crossings; Crash data analysis; Linear regression analysis.

1. INTRODUCTION

When a railway line crosses a road or a path at the same level is called a LC. The number of crashes at railway-roadway LCs has increased annually as shown in Table 1 [1]. Crashes at railway-roadway LC 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 LCs 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 LCs. The main objective of the study was to identify and investigate the different characteristics that contribute to crashes at LCs.

Table 1. Details of Level Crossings Crashes Between 2000 to 2010 [1]

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Number of crashes	53	7	30	55	31	60	60	65	43	66	75
Fatalities	5	19	13	10	6	48	6	12	16	20	11
Injuries	25	74	45	35	26	70	33	64	33	53	63

Ishak et al. [2] done a study on railway crossing safety in South Australia in identifying the LC characteristics using Petri Nets approach. Kumar [3] done research in India on road user behavior at LC. A study done by Amarasingha et al. [4] in Sri Lanka showed that having secured roadway-railway LC was failed since there were number of road crashes taking place in LCs due to unprotected railway crossings. Therefore, it is important to investigate the LC characteristics in LCs in Sri Lanka.

2. DATA AND METHODS

The study was conducted along the railroad from Colombo to Polgahawela, an approximate distance of about 72 Km. The maximum permissible speed between Colombo and Meerigama is 80 Kmph and between Meerigama to Polgahawela 72 Kmph. This section consists of fully automatic color light tertiary. The track system from Polgahawela to Ragama is double lined and Ragama to Colombo section consists of three lines. All LCs along the Mainline were visited and temporary obstructions which affected sight distance, traffic control systems related to each railway crossing, details of the operating system, whether categorizing as an active or a passive, and gradient of that roads at crossing were recorded by observation. The angle between railway and roadway was measured using a smart phone app. The google map was used to measure the sight distances to the railway gate from the both of the side and to measure the distance to the nearest curvature of the railway track. That was verified by the field measurements. The grade separation was approximately measured using a meter ruler at each of railway-roadway level crossing. The maximum number of train speed was noted down along the railway line speed signboards. Also, data on warning signs availability, light signals availability, type of the gates, and type of the gate opener collected using the data collection sheet. Under these observational surveys the driver behavior, geographical location of the crossings, geometry, prime safety precautions were obtained from the Sri Lanka Railway (SLR). Visibility issues of highway users, permissions, the instructions coming to the gate operation, gate operator availability, sight distance for gate from upside, sight distance for gate from down side, grade separation, distance to nearest curvature of rail line from Colombo direction, distance to nearest curvature of rail line from Polgahawela direction, number of railway tracks, roadway lanes per one direction, and number of trains that operated throughout a day were collected. For the Average Daily Traffic (ADT) estimation, traffic counts were obtained from direct filed surveys. For the selected rail line for the past four years crash data (2013-2016) were collected through the SLR crash data records. Crashes happened from year 2013 to 2016 between Colombo to Polgahawela stations at Mainline railway is shown in Table 2.

Table 2. LC Crash Statistics from Colombo to Polgahawela during 2013-2016

Crash category		**2013**	**2014**	**2015**	**2016**
Fatality crashes		0	0	4	1
Non grievous crashes		1	12	4	10
Damage only crashes		2	6	8	10
Total crashes		3	18	16	21

Multiple linear regression analyses were done by taking two independent variables at a time. Multiple linear regression analysis was performed to check how the distance to nearest curvature of rail line from Colombo and Polgahawela direction, sight distance to LC from upside and downside and the LC traffic control system affected the dependent variable, crash data.

3. RESULTS AND DISCUSSION

The effect of the distance to nearest curvature from both Colombo and Polgahawela directions against the crash occurrence shows in Table 3. The distance to nearest curvature from Colombo direction and Polgahawela direction has p- values of 0.723 (>0.05) and 0.05 (=0.05) which means only the nearest curvature distance from Polgahawela side is the significant predictor of crash data at 5% significant level. According to obtained model, there is no significance effect of nearest distance to the curvature towards Colombo side on LC crash occurrence.

Table 3. Effect of the Distance to Nearest Curvature from Both Colombo and Polgahawela Directions on the Crash Occurrence

	Unstandardized Coefficients	t	p	95% Confidence Interval for Beta

Model	Beta	Std. Error			Lower Bound	Upper Bound
Constant	-.615	.720	-.855	.396	-2.056	.825
Distance to nearest curvature along rail line- Colombo direction *(X_1)*	.003	.008	.357	.723	-.013	.019
Distance to nearest curvature along rail line- Polgahawela direction *(X_2)*	.017	.009	1.999	.050	.000	.034
Dependent Variable: Number of Crashes						

Similarly, the sight distance from the upside and the downside had p-values of 0.787 (>0.05) and 0.766 (>0.05) which makes they are not significant predictors of crash data. The availability of an active protection system had a significant value of 0.891 (> 0.05). The availability of a passive protection system had a significant value of 0.591 (> 0.05). Therefore, the available traffic control system was not a significant predictor of occurrence of crashes at the considered LCs.

4. CONCLUSION

Data pertaining to the sixty-two LCs found between Colombo and Polgahawela has been collected. It would be better, if further studies at different parts of the country could be included in future which would allow to do a comprehensive data analysis. To increase LC safety, it is suggested to provide speed breakers (humps) on approaches to LC along with the road signs so that road vehicle drivers are reminded to be careful and reduce their speed, install mirrors along the railway track so that road vehicle drivers can see whether the train is moving on the track, and to also provide whistle boards along the railway track so there is continuous whistling on approach to the LC.

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