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RESEARCH ARTICLE

Improvement of pedestrian safety and traffic flow regulation at the railway junction, Kandy

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Abstract: The junction near the Kandy railway station needs improvement as a solution to the traffic congestion at the location, especially during the peak hours of the day. The existing problem was studied in detail and several reasons for this problem were identified. To identify the movement of traffic and pedestrians at the railway junction, traffic studies were conducted during weekdays and weekends. Vehicular traffic by vehicle category, vehicle movements, and pedestrian traffic patterns were studied after identifying the three peak hours (morning, mid-day and evening) of the day. A heavy pedestrian movement surrounding the study locality was observed due to the presence of several main government institutions around that junction. Pedestrian traffic flow, pedestrian volumes and the level of service were calculated by the results collected from the pedestrian traffic surveys. A questionnaire survey was carried out during the peak hours to collect the views of the pedestrians about the existing situation at the location and the results were used in the analysis. As a measure to reduce the traffic congestion and improved vehicular flow and pedestrian safety, an underground pedestrian crossing structure together with an at-grade signalised scheme was proposed and designed.

Keywords: Kandy traffic, railway junction, traffic signal design, underground pedestrian crossings.

INTRODUCTION

The Kandy railway junction is surrounded by several main government institutions. At present there are three pedestrian crossings across each road, a few meters away from the junction (Figure 1) with a heavy pedestrian movement (Appendices A and B), interrupting the vehicular flow at the intersection. According to past accident data gathered from the Kandy Traffic Police (2010) fatal and serious accidents have occurred around the vicinity due to heavy pedestrian activities in the area.

This study was conducted to address the problem of traffic congestion with the view of streamlining the vehicular flows and improving pedestrian safety at the location by minimising the interaction between pedestrians and vehicular movements. The main objective of this study was to examine the existing situation and provide a solution to facilitate safe and comfortable means of road crossing for pedestrians while allowing the traffic to flow smoothly.

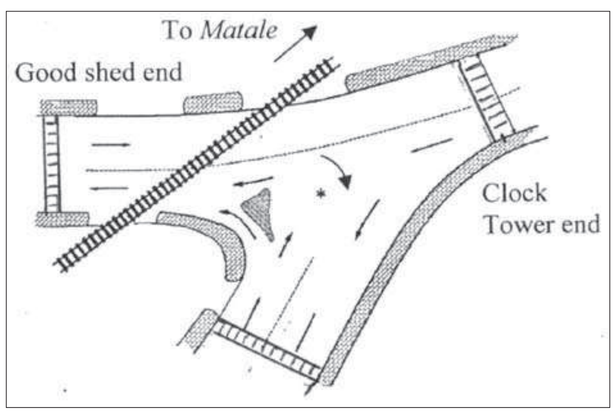

Figure 1: Layout plan

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METHODOLOGY

Several traffic surveys were conducted during the weekdays and weekends to identify the three peak hours of the day, peak hour traffic flows and turning movements of different vehicle categories at the railway junction. In addition, the pedestrian traffic surveys were also conducted to identify the peak hours and volumes of pedestrians using the three pedestrian crossings located in each road during the peak hours.

Identification of peak hours

The traffic flow of a road does not remain constant throughout the day or week, but varies both in space and time. A 'peak hour' represents the most critical period for operations and has the highest demand requirements for a given location. Therefore, capacity and other traffic analysis has to focus on the peak hour flows.

The Kandy town has a 5 % annual traffic growth rate (RDA, 2000). A major base road (William Gopallawa Mawatha) was selected to carryout the traffic survey on a weekday from 6:30 am to 9:30 am, 12:00 noon to 2:00 pm, and 4:30 pm to 6:30 pm, and on weekends from 7:30 am to10:30 am, 12:00 noon to 2:00 pm, and 4:00 pm to 6:00 pm, when the traffic is at its heaviest in order to identify the three peak hours of the day during morning, mid-day, and evening respectively. The counts were recorded at 15 min intervals. From the traffic surveys, the peak hours and the respective two-way traffic volumes were identified (Table 1).

Table 1: Identified peak hours (William Gopallawa Mawatha)

	Peak hours for weekdays	No. of vehicles	Peak hours for weekends	No. of vehicles
Morning peak	7:00 − 8:00 am	1821	9:30 − 10:30 am	1947
Mid-day peak	12:30 − 1:30 pm	1746	12:30 − 1:30 pm	1869
Evening peak	5:00 − 6:00 pm	1621	4:15 − 5:15 pm	1624

Classification of vehicles

The vehicles were categorized into ten separate groups. Passenger car unit (PCU) is used for expressing various types of vehicles having different characteristics by a common equivalent unit. PCU factors for vehicles in flat terrain were considered due to the nature of the site and are listed in Table 2.

Table 2: Equivalent passenger car units (PCU) for flat terrain and two-way roads

Vehicle category	PCU
Passenger car	1.0
Small bus	1.8
Bus	2.4
Light truck (4-wheel)	1.5
Medium truck (6-wheel)	2.0
Heavy truck (> 6-wheel)	3.8
Motor cycle	0.4
Three-wheeler	0.8
Land vehicle	3.8
Truck trailers	6.0

(UOM, 2006)

Turning movement survey

Turning movement surveys were carried out during the identified peak hours on a weekday and weekend, for the ten vehicle categories at the railway junction, which is a channelized intersection. All the roads have two lanes in each direction and it had a mixed flow pattern consisting of crossing, diverging and merging movements. Diverging and merging from the left side did not cause much problem but, crossing and diverging to and merging from the right side caused conflicts and difficulties to traffic moving on a straight path. The volume of vehicles making each turning movement was not constant during all three peak hours. It changed from one period to another and also within the peak hour. At present, traffic at the intersection is controlled by a policeman to minimise congestion during peak hours.

Pedestrian survey

Pedestrian surveys were carried out during weekdays and weekends to observe the volume of pedestrians using the three pedestrian crossings located in each road a few meters away from the junction for 12 consecutive 5 min periods, for each of the three peak hours (Appendices A and B). The rate of flow did not remain constant and varied within the hour, and within the week. A high pedestrian volume was observed during the weekends. It was observed that most of the pedestrians used the crossing at Goodshed end, as most of the government buildings and the main bus stand are located on that part of the junction.

Table 3: Identified peak hours for weekdays and weekends

	Location	Peak hours for weekdays	No. of pedestrians	Peak hours for weekend	No. of pedestrians
Morning peak	William Gopallawa Mawatha	7:00 – 8:00 am	556	7:15 – 8:15 am	650
	Clock tower end		559		591
	Goodshed end		1513		1781
Mid-day peak	William Gopallawa Mawatha	12:30 – 1:30 pm	708	12:30 – 1:30 pm	585
	Clock tower end		1008		1327
	Goodshed end		1315		1710
Evening peak	William Gopallawa Mawatha	5:00 – 6:00 pm	801	4:25 – 5:25 pm	646
	Clock tower end		1234		1532
	Goodshed end		1783		1288

Accident details

Information about the accidents for the past ten years at the railway junction and near the clock tower junction was collected from the Kandy Police Station (2010). Types of accidents that occurred at both places were property damages, injuries, serious injuries and fatal accidents. Most of the accidents had occurred due to the carelessness of both the pedestrians and the drivers.

After the construction of the underground pedestrian crossing structure near the clock tower junction at Kandy, a vast improvement of vehicular and pedestrian traffic flow and pedestrian safety at the locality was observed (Kandy Police station, 2010). There is a heavy vehicular traffic as five roads meet at this particular junction. Before the construction of the underground pedestrian crossing structure, there were six pedestrian crossings in the near vicinity and the police used to stop vehicles for long durations, which created traffic congestion at the clock tower junction. Currently the sidewalks are provided with guard rails to prohibit people crossing the road at unauthorized locations. All the pedestrian crossings in the vicinity are also closed. As the pedestrians are using the pedestrian underpass, the traffic congestion and the number of accidents at the clock tower junction have decreased considerably (Figure 2). Two fatal accidents were recorded during the construction stage of the pedestrian underpass at the clock tower junction.

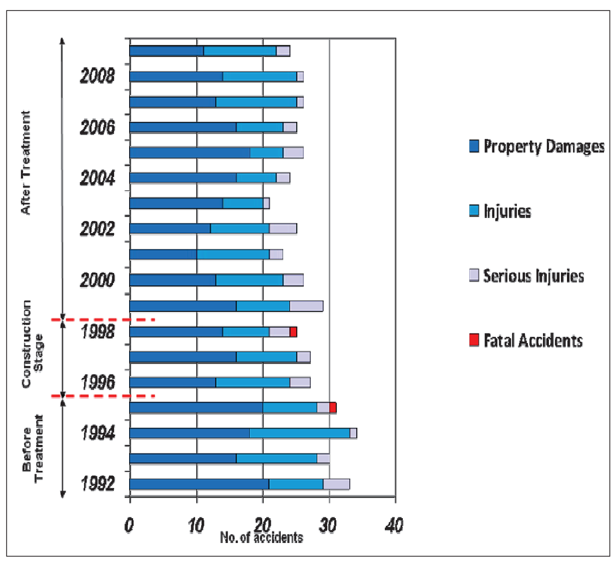

Figure 2: Road accidents at clock tower junction (before and after the construction of pedestrian underpass)

The problem at the Kandy railway junction is comparable to the clock tower junction. It is seen from the accident data in Table 4, that four fatal accidents had taken place during the past ten years at the Kandy railway junction. It should be noted that the real number of 'property damage' accidents is more than that is indicated in Table 4 from 2006 to 2010 due to the prevailing 'on the spot settlements' during this period. Providing a pedestrian crossing structure at the Kandy railway junction and preventing the road crossing other than using the pedestrian crossing structure appears to be a reasonable solution to the above problems.

Table 4: Accidents at the Kandy railway junction

Year	Property damages	Injuries	Serious injuries	Fatal
01.01.2010 - 06.02.2010	4	6	-	-
01.01.2009 - 12.12.2009	10	12	10	-
01.01.2008 - 12.12.2008	14	9	8	1
01.01.2007 - 12.12.2007	8	8	6	-
01.01.2006 - 12.12.2006	14	11	4	1
01.01.2005 - 12.12.2005	22	11	3	1
01.01.2004 - 12.12.2004	12	8	2	-
01.01.2003 - 12.12.2003	18	5	3	-
01.01.2002 - 12.12.2002	15	7	4	-
01.01.2001 - 12.12.2001	16	9	8	1
01.01.2000 - 12.12.2000	21	12	6	-

(Source: Kandy Police Station, 2010)

Questionnaire survey

A questionnaire survey was carried out during the three peak hours to collect the views of the pedestrians, about the existing crossing conditions at the Kandy railway junction and to obtain their suggestions to improve it. A sample of pedestrians between the age of 15 – 70, who were passing the railway junction for various purposes was selected for the questionnaire survey. The results indicated that the pedestrians were not satisfied with the existing pedestrian crossings at the particular junction because of the following reasons,

- The existing pedestrian crossings are not properly located,
- It takes more time to cross the road by using the pedestrian crossings because of the heavy traffic at the junction,
- Drivers of the vehicles do not like to stop their vehicles at the pedestrian crossings,
- The feel highly insecure existing pedestrian crossings

The pedestrians always wish to cross the road safely, and their suggestions to improve the pedestrian traffic flow at the junction with enhanced safety were obtained. Suggestions by pedestrians to improve the vehicular flow, pedestrian traffic flow, and safety are shown in Figure 3.

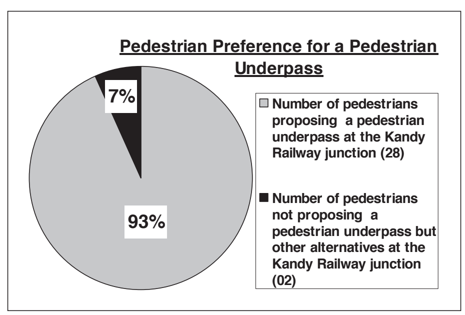

Figure 3: Questionnaire survey results

It was also noted that all the pedestrians that answered the questionnaire had already used the existing pedestrian underpass at the clock tower junction. Among those who were interviewed 93 % suggested constructing an underpass at the Kandy railway junction, based on the convenience they had experienced at the nearby underpass at the clock tower junction.

Suggestions obtained through the survey were:

- To install direction boards to identify the correct way that should be selected after entering the pedestrian underpass, specially for the use of those who are not residents of Kandy town
- There should be a good illumination system for both day and night to ensure the security of the pedestrians
- There should be planned precautions for emergency situations (fire, flood, heavy rain etc.)
- Control the entry of unwanted people into the pedestrian underpass
- Facilities for the elderly and disabled pedestrians should be provided

According to the above results it could be concluded that the most of the pedestrians favoured a pedestrian underpass for the Kandy railway junction, as a solution for the existing inconvenience at the location.

DATA ANALYSIS AND DESIGN

Capacity analysis and design of roads

From the data collected through traffic surveys, the existing traffic flow rates and the peak hours were identified. The corresponding Levels of Services (LOS) during the peak hours were calculated and the road was improved and designed to cater to the projected traffic 20 years from the present.

Basic definitions and general equations for designing *(Transportation Research Board, 1985)*.

Peak hour factor (PHF)

The maximum hourly volume of the day divided by the rate of flow during peak 15 minute period within the Peak Hour is a measure of traffic demand fluctuation within the Peak Hour.

$$\text{Peak Hour Factor (PHF)} = \frac{\text{Hourly volume}}{\text{Peak rate of flow (within the hour)}}$$

$$PHF = V / (4\times V_{15})$$

Service flow (SF)

The actual rate of flow for the peak 15 minute period was expanded to an hourly volume and expressed as vehicles per hour or vehicles per hour per lane.

$$SF = V / PHF$$

Multilane highways

Capacity analysis and design was carried out along the William Gopallawa Mawatha and at two ends of the S.W.R.D. Bandaranayake Mawatha as recommended by the US Highway Capacity Manual (1985).

$$SF_i = c_j \times (v/c)_i \times N \times f_w \times f_{HV} \times f_E \times f_p$$

$$f_{HV} = 1/ [\ 1+ P_T (E_T-1) + P_B (E_B-1)\ ]$$

Where,

F_i	=	service flow rate; the maximum flow rate that can be accommodated by the multilane highway segment under study in one direction under prevailing roadway and traffic conditions, while meeting the performance criteria of LOS_i, in vph
c_j	=	capacity per lane for a multilane highway with design speed *j*
N	=	number of lanes in one direction
$(v/c)_j$	=	maximum volume-to-capacity ratio while maintaining the performance characteristics of LOS *j*
f_w	=	adjustment factor for lane width and/or lateral clearance restrictions
f_{HV}	=	adjustment factor for the presence of heavy vehicles in the traffic stream
f_E	=	adjustment factor for the development environment and type of multilane highway
f_p	=	adjustment factor for driver population
E_T, E_B	=	passenger car equivalents for trucks and buses, respectively
P_T, P_B	=	proportion of trucks and buses, respectively in the traffic stream

The details of existing and designed/proposed roads are indicated in Table 5.

Traffic signal design for Kandy railway junction

The critical volume of vehicles approaching towards the railway junction during the morning peak is shown in Figure 4.

After considering all the different traffic flow scenarios the following stage arrangement was established to facilitate all the traffic flow movements with a minimum number of stages (i.e., total of 3 stages as indicated in Figure 5).

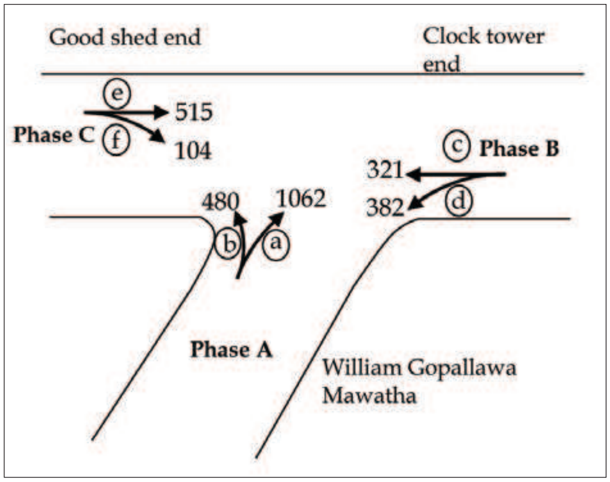

Figure 4: The critical volume of vehicles approaching towards the railway junction during the morning peak

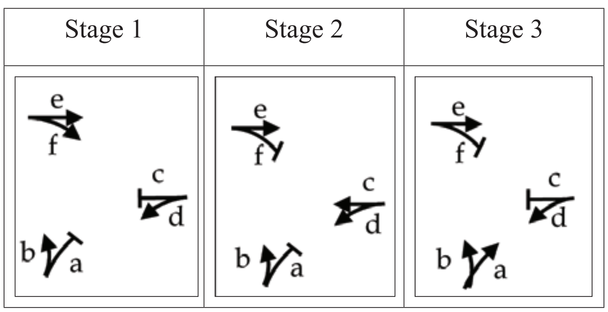

Figure 5: Staging diagrams for traffic flow movements

By using Webster's method (Salter & Hounsell, 1996):

Determination of equivalent hourly flow:

$$\text{Equivalent hourly flow} = \frac{\text{Peak hour volume}}{\text{PHF}}$$

Determination of total lost time (L) :

$$L = \sum_{i=1}^{\emptyset} l_i + R$$

l_i = lost time for phase i
R = total all - red time during the cycle

Since there is no all-red phase, R = 0

There are three phases and the total loss time (L) can be calculated

$L = \sum Y_i = 3 \text{ x } 5 = 15$ s/cycle (assuming lost time for phase is 5 seconds).

Determination of Y_i and $\sum Y_i$:

$$Y_i = \frac{\text{Observed flow}}{\text{Saturation flow}}$$

Determination of optimum cycle length (C_0) :

$$C_0 = \frac{1.5L + 5.0}{1 - \sum_{i=1}^{\emptyset} Y_i}$$

Determination of the total effective Green time (G_{te}) :

$$G_{te} = C - L$$

Effective Green time for phase i is obtained from

$$G_{ei} = \frac{Y_i}{Y_1 + Y_2 + \cdots + Y_\emptyset} G_{te}$$

Actual green G_{ai} for each phase is obtained by,

$$G_{ai} = G_{ei} + l_i - \tau_i$$

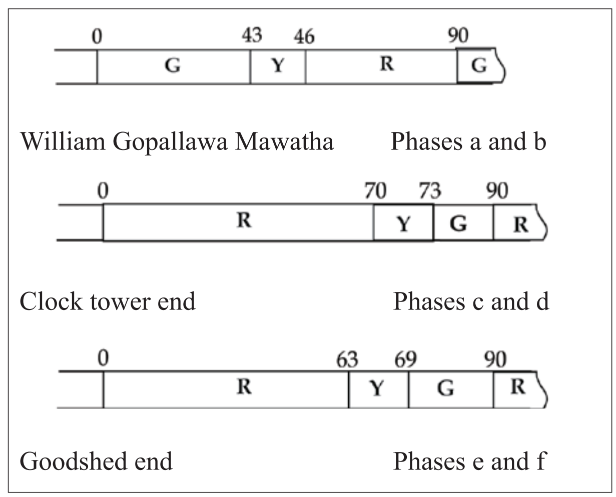

Figure 6: Phasing diagrams for the Kandy railway junction

Capacity analysis and design of pedestrian crossing structure

From the data collected from the pedestrian traffic surveys (Appendices A and B), the existing pedestrian flow rates during the peak hours and the Levels of Service (LOS) were calculated. Then the pedestrian crossing structure was designed to cater to the pedestrian volumes projected for 20 years. The basic relationships for pedestrian design *(Transportation Research Board, 1985)*.

Forecasting the pedestrian flow in n years,

$$P_n = P_0 (1 + r / 100)^n$$

Where,
P_n = forecasted pedestrian flow for n years
P_0 = present pedestrian flow
r = reasonable growth rate factor
n = number of years

Designing the width of the subway for an assumed LOS

Specimen calculation (William Gopallawa Mawatha)

Total volume crossing (peak hour) = 650 ped/hr
Pedestrian flow rate per unit per unit width of crossing = 650/60 ped/min/ft
= 11 ped/min/ft

As per the Highway Capacity Manual (1985) the existing Level of Service is D.

Hence, forecasted pedestrian flow for 20 years,

$$P_{20} = 650 (1 + 11/100)^{20} = 810 \text{ ped/hr}$$

Design width of subway for LOS B,
Assume;

Pedestrian flow rate = 2.5 ped/min/ft

$$\text{Proposed width} = \frac{\text{Pedestrian volume per hour}}{\text{Flow rate}}$$

Proposed width = 2 x 810/(60 x 2.5)
= 10.8 ft (3.3 m)
Hence proposed subway width = 4.0 m

Similarly the subway widths of all three crossings were calculated (Table 6).

It should be noted that when planning for pedestrians the main objective should be to encourage orderly and safe movement of pedestrians and vehicles without interference from each other. Pedestrians should be guided away from traffic danger spots in main roads by providing proper facilities, and without interference from the moving traffic as much as possible (Weerasekera, 2009).

Pedestrian crossing structure

The pedestrian crossing structure consists of three accesses tunnels, which are from the police quarters

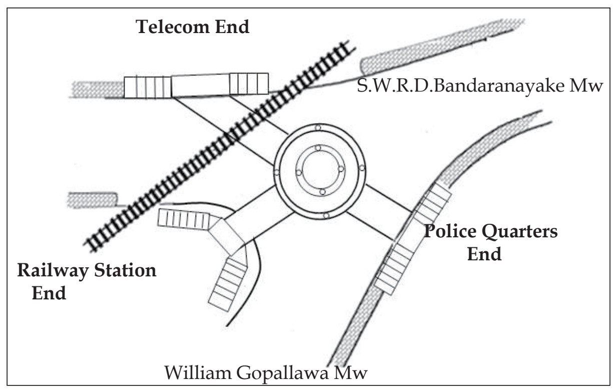

Figure 7: Proposed pedestrian subway at Kandy Railway Junction

Table 5: Results of the existing and designed roads

Location	Present pedestrians traffic	Projected pedestrians traffic	Proposed width of pedestrian subway	Pedestrian traffic after design and LOS
William Gopallawa Mawatha	650 ped/hr LOS D	810 ped/hr	4.0 m	3.71 ped/min/m LOS A
S.W.R.D. Bandaranayake Mawatha-Clock tower end	1532 ped/hr LOS E	1910 ped/hr	4.5 m	8.04 ped/min/m LOS B
S.W.R.D. Bandaranayake Mawatha-Goodshed end	1781 ped/hr LOS F	2220 ped/hr	5.0 m	8.20 ped/min/m LOS B

Table 6: Results of the existing pedestrian conditions, proposed widths of the pedestrian subway and the expected level of service

Location	Before design (in 2011)	After design (20 years from 2011) (i.e. 2031)
William Gopallawa Mawatha	Level terrain, Lane Width 3.25m No shoulders 4-Lane (2-Lanes each direction), two-way road Obstruction on one side of roadway Actual flow 1075vph LOS C, $(V/C)_i$= 0.47	Level terrain, Lane width 3.66m, Shoulder width 1.83m 6-Lane (3- lanes each direction), two-way road Obstruction on one side of roadwayPredicted flow rate 2856vph LOS C, (V/C)i= 0.75
S. W. R. D Bandaranayake Mw - clock tower end	Level terrain, Lane Width 3.05m No shoulders 4-Lane (2-Lanes each direction), two-way road Obstruction on both sides of roadway Actual flow 1145vph LOS C, $(V/C)_i$= 0.5	Level terrain, Lane width 3.66m, Shoulder width 1.83m 6-Lane (3- lanes each direction), two-way road Obstruction on one side of roadway Predicted flow rate 3037vph LOS C, $(V/C)_i$= 0.75
S. W. R. D Bandaranayake Mw - Goodshed end	Level terrain Lane Width 3.35m No shoulders 4-Lane (2-Lanes each direction), two-way road Obstruction on both sides of roadway Actual flow 800vph LOS B, $(V/C)_i$= 0.34	Level terrain Lane width 3.66m, Shoulder width 1.83m 6-Lane(3- lanes each direction), two-way road Obstruction on one side of roadway Predicted flow rate 2124vph LOS B, $(V/C)_i$= 0.5

end, railway station end, and the telecom end (Figure 7). All access tunnels are connected to a central circular section where a portion of the space is allocated for small scale shops, similar to the existing pedestrian underpass at the clock tower junction. The central circular section has a diameter of 16 m. The centre of the subway system is open to the sky, which may be sufficient to provide the necessary ventilation required for the subway. This hole has a diameter of 8 m, which can also be used as a central island of a roundabout with three lane circulation. There are two ring beams which have the diameters of 8 m and 16 m, respectively around the ventilation hole and the central circular section. These two beams are supported by four numbers of props and connected to the bottom ring beams. The subway has a clear height of 3 m.

DISCUSSION AND CONCLUSION

According to the study, it was observed that the present capacity of the intersection is not adequate, and improvements were needed to overcome the existing traffic congestion at the Kandy railway junction. With the suggested improvements, initially the LOS of all three roads will improve, but in 20 years time it will again decline to the present level of service in all three roads (Table 6). Hence a new design was introduced to accommodate the forecasted traffic flows for a period of 20 years.

Past accident details emphasise the importance of improving the pedestrian safety at the Kandy railway junction. By carefully studying the detailed accident records maintained by the Kandy Traffic Police it was clear that most of the accidents had occurred due to the carelessness of both the pedestrians and the drivers. It was also observed that the accidents at the location was aggravated by improperly located pedestrian crossings and many other design flaws.

The present congestion experienced at the railway junction is not only due to the inadequacy of current capacity of the intersection, but also due to the heavy pedestrian movements at the junction. Therefore, a pedestrian crossing structure was designed for a period of 20 years to facilitate the pedestrians to cross the road safely and allowing the traffic to flow smoothly.

The designed underground pedestrian crossing structure consists of three access subways from telecom, railway and police quarters ends. The access subways were designed with a width to give a higher level of service for the pedestrians. A ventilation hole at the centre of the structure provides necessary ventilation to the structure. The subway will have a clear height of 3m. The ventilation hole of the pedestrian crossing structure also used as a central island of a roundabout with three lane circulation and it also help to smooth the traffic flow at the junction.

The traffic signal light system has a total lost time of 15 seconds. When the cycle length is 60 seconds, the lost time constitute a larger proportion. Hence it is preferable to have a longer cycle length of 90 seconds. The traffic signals were designed to improve the traffic flow and to decrease the average travel time through the intersection for traffic projections over a period of 20 years. Hence the designed crossing structure at the Kandy railway junction will improve the pedestrian safety as well as reduce the hindrances to traffic flow.

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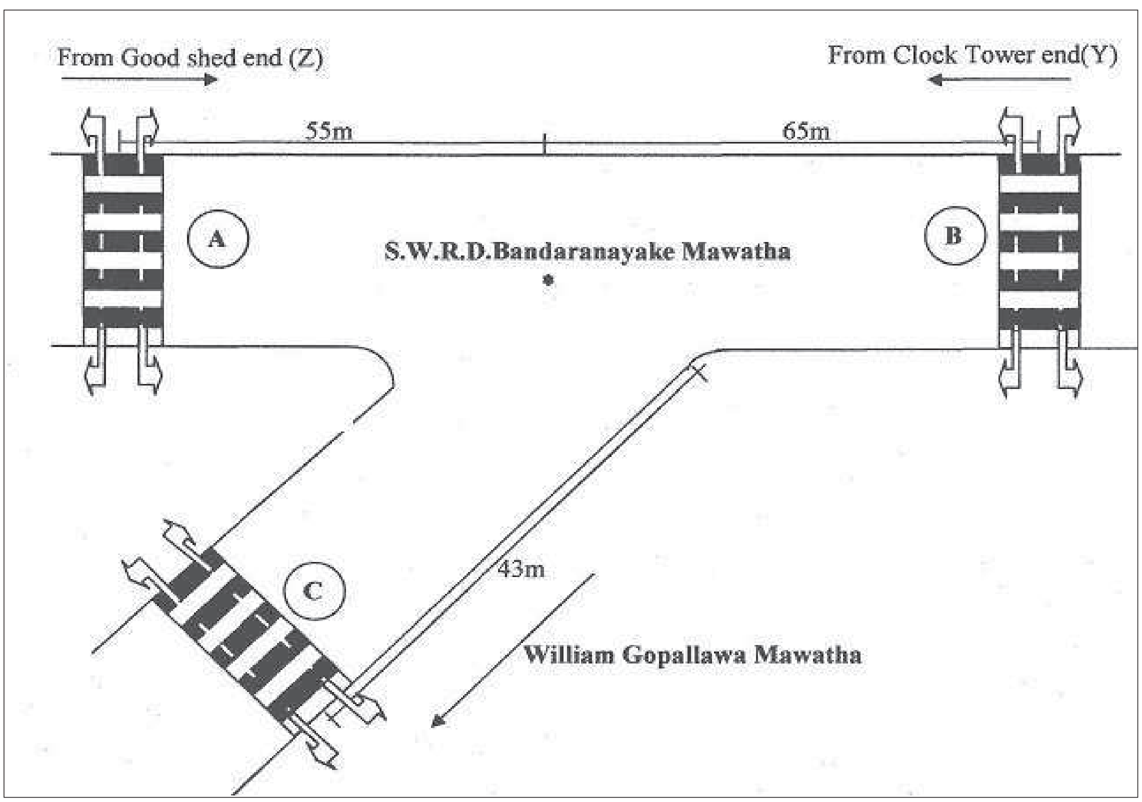
APPENDIX A

Field sheet for Pedestrian Count at Kandy Railway junction for weekday

		William Gopallawa Mw				From Goods shed end				From Clock Tower			
		↰	↱	↲	↳	↰	↱	↲	↳	↰	↱	↲	↳
Morning Peak	7.00am-7.05am	4	65	2	8	45	29	77	54	19	26	5	11
	7.05am-7.10am	3	30	1	2	76	47	40	8	16	14	1	3
	7.10am-7.15am	3	26	9	20	31	28	50	8	19	9	-	11
	7.15am-7.20am	1	23	6	11	35	16	46	9	17	12	5	5
	7.20am-7.25am	-	12	1	1	38	14	30	4	15	28	6	1
	7.25am-7.30am	1	42	1	8	75	54	89	11	23	12	1	8
	7.30am-7.35am	-	18	4	31	47	50	31	9	32	20	3	5
	7.35am-7.40am	-	35	5	16	32	43	16	7	26	10	3	14
	7.40am-7.45am	-	17	3	20	31	44	14	12	17	10	-	5
	7.45am-7.50am	6	20	3	19	14	40	26	3	15	15	3	7
	7.50am-7.55am	1	18	5	18	29	40	26	7	17	10	3	11
	7.55am-8.00am	-	28	7	3	24	34	16	4	47	1	6	12
Mid day peak	12.30pm-12.35pm	1	43	8	21	38	39	26	16	70	17	1	9
	12.35pm-12.40pm	2	37	19	19	55	43	7	13	55	12	-	12
	12.40pm-12.45pm	4	33	1	11	22	36	11	22	67	14	4	11
	12.45pm-12.50pm	-	25	10	9	37	41	17	14	57	20	1	19
	12.50pm-12.55pm	-	55	3	7	43	45	7	28	41	6	7	20
	12.55pm-1.00pm	2	29	5	5	33	69	12	19	48	6	6	11
	1.00pm-1.05pm	5	45	8	9	30	31	8	19	65	11	3	12
	1.05pm-1.10pm	2	29	2	5	25	39	7	20	32	9	11	8
	1.10pm-1.15pm	-	44	9	16	44	32	19	36	69	5	1	12
	1.15pm-1.20pm	1	33	6	7	23	29	19	34	64	14	3	17
	1.20pm-1.25pm	2	19	5	14	19	48	15	25	59	7	1	11

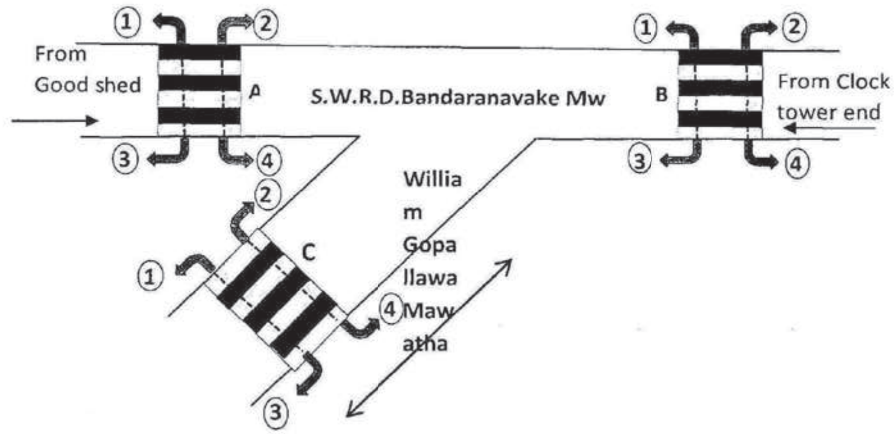
	1.25pm-1.30pm	1	69	16	12	24	32	20	24	58	7	2	13
Evening peak	5.00pm-5.05pm	-	49	10	37	68	31	96	22	82	2	1	17
	5.05pm-5.10pm	1	38	7	21	47	30	43	39	70	5	2	25
	5.10pm-5.15pm	5	43	9	21	71	30	32	22	75	1	6	18
	5.15pm-5.20pm	-	67	2	19	27	35	41	31	93	4	3	21
	5.20pm-5.25pm	2	33	3	14	30	25	48	28	89	7	4	14
	5.25pm-5.30pm	2	48	7	12	36	25	23	14	89	1	2	20
	5.30pm-5.35pm	1	64	3	13	29	21	68	64	98	9	1	14
	5.35pm-5.40pm	1	53	3	12	37	17	52	43	84	19	3	11
	5.40pm-5.45pm	-	48	7	5	37	30	50	47	76	15	1	15
	5.45pm-5.50pm	1	35	5	4	33	33	34	30	73	3	-	11
	5.50pm-5.55pm	1	40	4	7	26	26	24	17	49	10	1	7
	5.55pm-6.00pm	-	29	1	14	53	53	38	35	62	7	4	10



APPENDIX B

pedestrian count sample fieldsheet – saturday

Pedestrian count at Kandy Railway Junction on Saturday



Time	William Gopallawa Mw				From Good shed end				From Clock tower end			
	①	②	③	④	①	②	③	④	①	②	③	④
7.00am-7.05am	1	44	3	7	53	26	59	14	19	10	2	14
7.05am-7.10am	0	37	3	0	23	13	54	19	15	7	1	11
7.10am-7.15am	0	33	0	5	27	44	50	26	17	3	1	10
7.15am-7.20am	2	25	0	9	23	39	52	22	43	10	5	11
7.20am-7.25am	0	37	3	11	34	47	48	30	28	6	1	25
7.25am-7.30am	0	22	8	22	67	73	51	26	9	6	2	9
7.30am-7.35am	2	33	7	16	22	29	57	19	28	19	2	18
7.35am-7.40am	0	42	4	6	36	49	50	32	23	3	1	1
7.40am-7.45am	0	48	2	11	22	32	44	28	29	2	3	17
7.45am-7.50am	2	36	5	6	31	30	49	28	23	8	1	8
7.50am-7.55am	2	36	10	12	24	36	52	25	31	6	4	11
7.55am-8.00am	8	35	2	2	26	43	48	29	24	11	1	16