

## AN INVESTIGATION ON TRAFFIC ISSUES AT GETAMBE ROUNDABOUT

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**Abstract:** Getambe roundabout is vulnerable to traffic congestions causing a bottleneck for the vehicles entering and leaving through Western Approach to Kandy city. The aim of this study is to identify the traffic issues at Getambe Roundabout and provide suitable mitigation measures to overcome the problem. The scope of the study is to propose a suitable method to increase the capacity level of the roundabout for traffic in thirty years of time period. According to the traffic flow data, the level of service of A1 road on which the roundabout is located is 'F' based on AUSTRROADS Standards. It is the worst scenario. In the meantime the capacity of the roundabout was not adequate according to Federal Highway Administration criteria. Collision diagram was developed based on accident records and it is revealed that roundabout is one of the most severely vulnerable place in Kandy. Location of the nearby railway crossing causes long queues of vehicle quite often. Considering all the traffic issues, four combinations were analysed to find out the suitable solution along with the option of widening the roundabout into two lanes, which is a part of each combination. Four combinations; (1) Tunnel between A1 road and Sirimavo Bandaranayake Mawatha, (2) bypass road from William Gopallawa Mawatha (WPM) to Galaha road parallel to the railway track, (3) two way flyover from A1 road to William Gopallawa Mawatha and (4) improvement of access roads to the Getambe Roundabout were analysed to come up with the suitable solution. Second and forth combinations were rejected based on the volume to capacity ration of the roundabout. Out of the remaining, Analytical Hierarchy Process (AHP) was followed to select the best combination, which is the construction of a two way flyover from A1 road to WGM along with the widening of the roundabout into two lanes. Further Benefit/Cost analysis was performed to justify the selective alternative over the others.

**Keywords:** Getambe Roundabout, Traffic issues, Tunnel construction, Widening of the roundabout, Flyover

### 1. Introduction

Road traffic congestion is a major problem in many cities all around the world. Motorists and passengers waste their valuable time in streets due to heavy traffic congestion and it increases the air pollution with more carbon emission. This is a common issue in many cities in Sri Lanka. However, Kandy city as the second largest city in Sri Lanka is severely impacted with lack of road facilities. It has been identified many difficulties to expand the existing road network in Kandy city due to the geographical and historical values. Kandy is located in a mountainous terrain 116 km away from Colombo in the central province of Sri Lanka. It is recognized as the second busiest city of the country with a population density of around 2,500 persons per sq.km [01]. A sacred site for the global Buddhist community due to the situation of

the temple of tooth, Kandy was declared a world heritage site by UNESCO in 1988 [01].

The hill capital of Sri Lanka is Kandy, where there are several ancient places. Approximately 325,000 people enter the Kandy during day time of a week day which includes around 90,000 for employment and 60,000 for education [04]. Presently, the share of public transport is around 64% of motorized trips while railway share is only 2%. Meanwhile, about 5000 bus trips are made every week day, carrying 200,000 passengers [04]. In addition, 1000 school vans entering the city on school days carrying over 16,000 passengers and the rest of nearly 45,000 people are using their private vehicles [08].

The heavy traffic congestion in this area destroy the energetic working hours during

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morning and evening peak hours and adversely impact on the economy. Moreover, the noise and emission of the vehicles contaminate the environment and affect the health of people. In this study, the possible causes of traffic congestion were identified by traffic survey in this area. Feasible solutions are presented based on the analysing of the research study to minimize the existing traffic congestion in the study area of Getambe Roundabout. There are several public and commercial buildings are located around this area. This area is heavily congested during morning and evening peak hours and significantly contributes on traffic congestion in Kandy city. These waste many effective hours of people making adverse impact on economy. Further, the accumulated emissions of the vehicles during congestions pollute the atmosphere which creates physical and mental health issues of the inhabitants.

Figure 1 shows the current scenario of the study area. It illustrates the number of roads, railway track, institutes are compacted in a small area. Many people utilize this area which creates large number of trips and make complex traffic congestion at rush hours. The waste time could have productively been used if there is a proper solution to manage this issue.

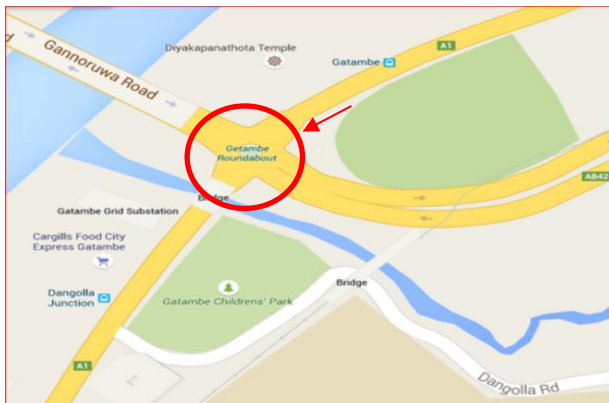


Figure 01: Current scenario of the study area

The aim of this study is to identify the traffic issues at Getambe Roundabout and provide suitable mitigation measures to overcome the problem. The scope of the study is to propose a suitable method to increase the capacity level of the roundabout for traffic in thirty years of time period. The existing

dimensions of the roundabout is given in the figure 02.

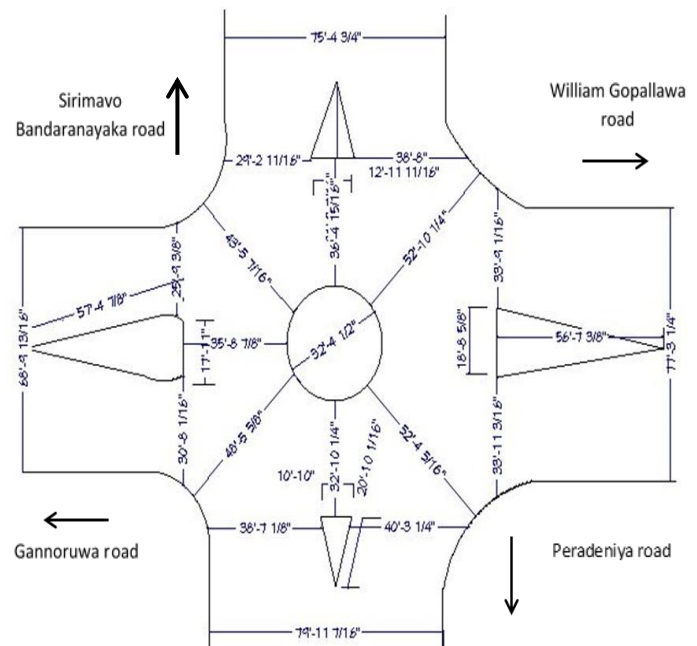


Figure 02: Dimensions of roundabout

## 2. Problem identification

The following activities were conducted to identify the problem

- Volume count survey
- Turning movement survey
- Pedestrian survey
- Accident survey
- Delay survey

### 2.1 Turning moment survey

A turning movement survey was done to identify the movement of the traffics at the Getambe roundabout. The results obtained from the turning movement survey are shown in figure 03.

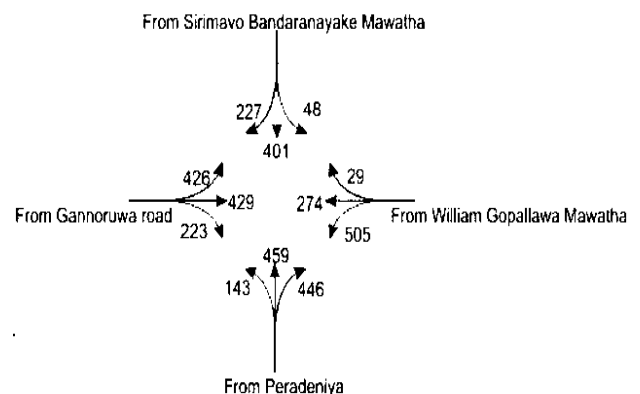


Figure 03: Turning movement survey

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Traffic volume at the Getambe roundabout was calculated as shown in figure 04. The resultant traffic flow data were analyzed. According to the Austroads classification the level of service of the road A1 is class F. This is the worst scenario where the traffic flow can be described as a moving car park.

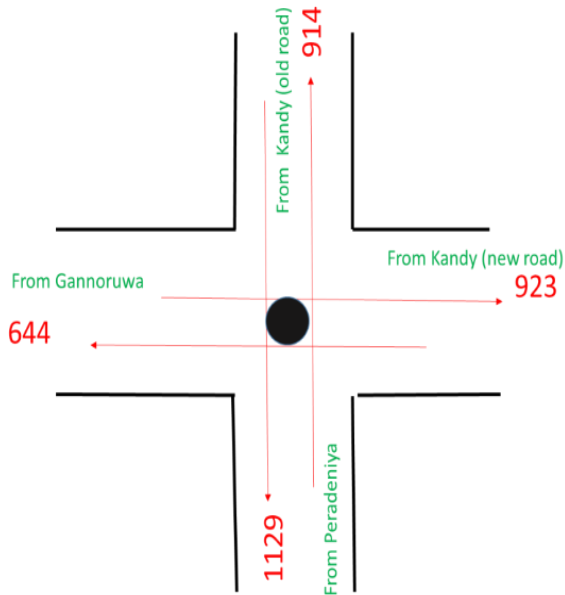


Figure 04: Traffic volume at roundabout

### 2.2 Accident survey

Collision diagram was developed based on accident records as shown in figures 5, 6 and 7 and it is revealed that roundabout is one of the most severely vulnerable place in Kandy.

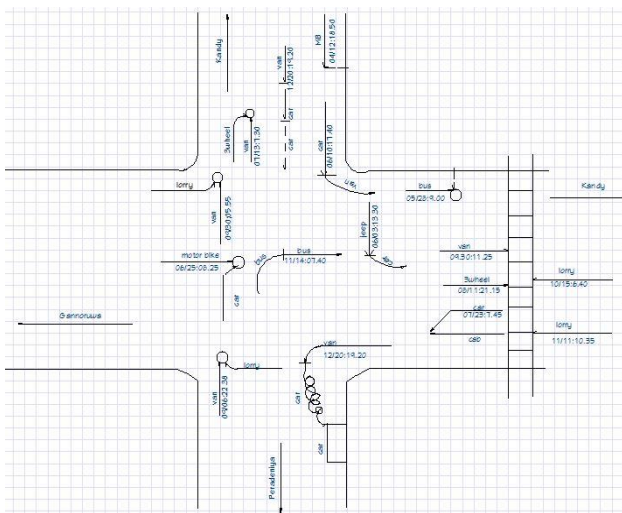


Figure 05: Collision Diagram for the first six months of 2014

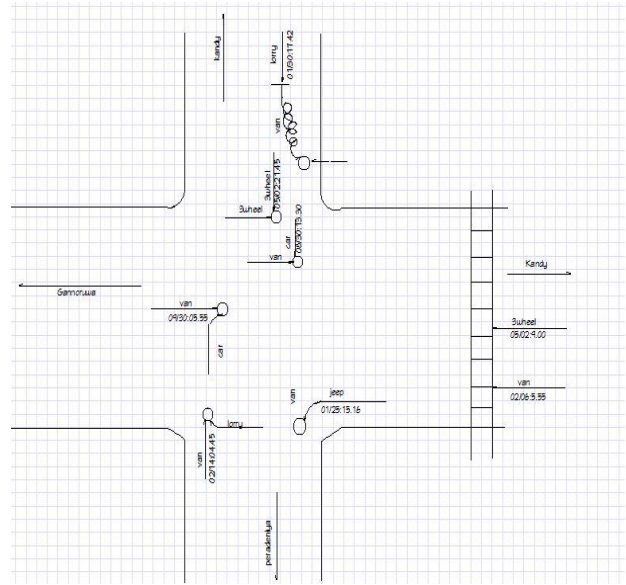


Figure 06: Collision Diagram for the second six months of 2014

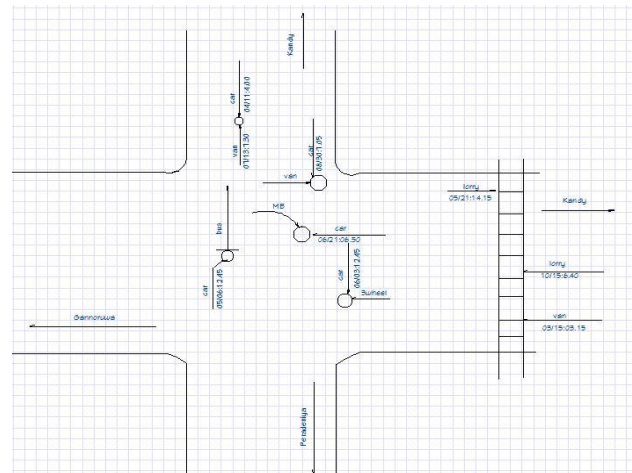


Figure 07: Collision Diagram for the first six months of 2015

The accident details and the collision diagrams drawn for the roundabout shows that the roundabout is vulnerable to accidents and attention should be paid immediately to overcome these issues.

### 2.3. Delay survey

Delay survey was done to obtain the delay due to the train passing. A train gate is located at near to the Getambe roundabout and it is a level crossing as shown in the figures 08 and 09. Due to that, when the train was passing, the gate was closed and, due to the queue that was formed due to this gate closing, would be a main reason for the congestion at the roundabout.

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Figure 08: Level crossing of railway track

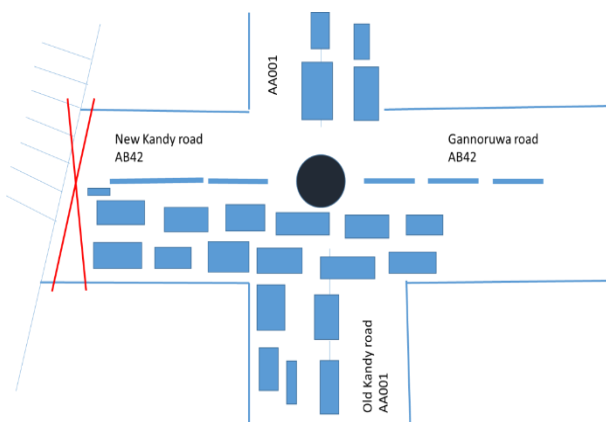


Figure 09: Simulation for traffic congestion

Due to the railway crossing and frequent train movement especially during peak hours, congestion is formed at the roundabout. Location of the nearby railway crossing causes long queues of vehicle quite often. From the delay survey data it is clear that there is a considerable delay causing a bottleneck at the roundabout.

#### 2.4 Pedestrian survey

There are several pedestrian crossings around Getambe Roundabout. Vehicle flow interrupts when pedestrian cross in operation. This will create shockwave in the vehicle flow & leads to delays. At Getambe Roundabout, vehicle flow is high. Due to high flow rate, velocity of the vehicles is low. Pedestrians used to cross through these slow moving vehicles in illegal way. This leads further reduction in the flow rate and velocity.

### 3. Alternative solutions

#### 3.1 Possibilities of tunnel construction

Tunnel construction is one of the alternatives, which will explore suitable way to decrease the traffic congestion at Getambe junction. A layout of the tunnel (Figure 11) is designed based on the traffic survey at Getambe junction as shown in figure 10.

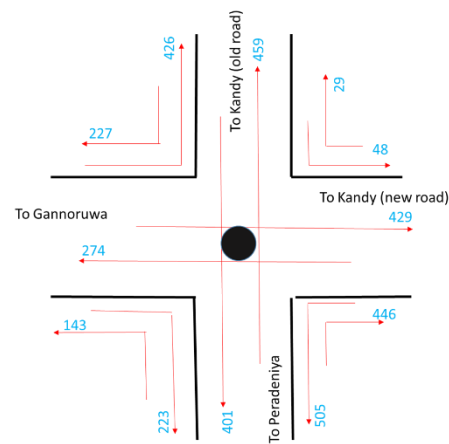


Figure 10: Traffic Flow data

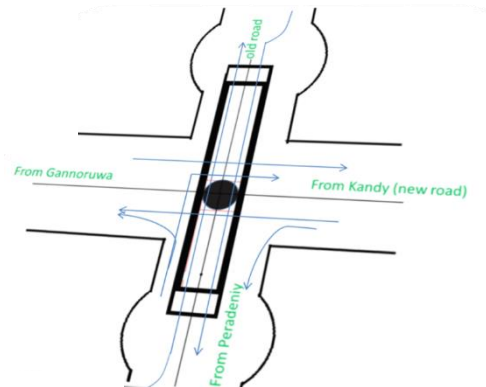


Figure 11: Layout of the Tunnel

Forecasted level of service (LOS) for the road segment after construction of tunnel is found as LOS (C). Level of service of the road segment can be improved from LOS (F) to LOF (C) by providing such a tunnel as shown in figure 09. Forecasted level of service (LOS) inside the tunnel is found as LOS (D).

Capacity Check of Getambe Roundabout was performed after the tunnel construction with respect to FHWA Capacity check for Roundabouts as given in table 01. Volume/Capacity ratios exceeded for two road segments such as Gannoruwa and William Gopallawa roads.



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Table 01: Volume to Capacity Ratio of the Getambe Roundabout

Direction of entering to the roundabout	Entry volume (psu/hr)	Circulatory volume (psu/hr)	Maximum Entry volume, capacity from FHWA method (Veh/hr)	Volume/Capacity ratio
Peradeniya road	618	551	910	0.68
Gannoruwa road	1131	498	980	1.15
Sirimavo Bandaranayaka road	286	1152	670	0.42
William Gopallawa road	840	470	790	1.06

Forecasted traffic Survey analysis after 30 years of time period were performed to predict the effectiveness of tunnel. Geometric Progression Method was used for the intended purpose. Forecasted level of service (LOS) for the road segment after 30 years of time period is found as LOS (D). Forecasted level of service (LOS) inside the tunnel after 30 years is found as LOS (D).

Capacity Check of Getambe Roundabout was performed after 30 years with respect to FHWA Capacity check for Roundabouts as given in table 02. Volume/Capacity ratios exceeded for all the road segments. This is the worst scenario where the traffic flow can be described as a moving car park.

Table 02: Volume to Capacity Ratio of the Getambe Roundabout after 30 years

Direction of entering to the roundabout	Entry volume (Veh/hr)	Circulatory volume (Veh/hr)	Maximum Entry volume, capacity from FHWA method (Veh/hr)	Volume/Capacity ratio
Peradeniya road	832	742	824	1.009
Gannoruwa road	1524	671	855	1.782
Sirimavo Bandaranayaka road	385	1552	330	1.167
William Gopallawa road	1132	633	860	1.317

### 3.2 Possibilities of flyover construction

A flyover can be constructed to reduce the traffic jamming conditions around Getambe Roundabout. According to the conditions and the nature of traffic flow at Getambe Roundabout most appropriate proposal is to construct the flyover from Peradeniya end of the roundabout to William Gopallawa Mawatha. Movement of vehicles to the both directions will be facilitated by the flyover

and it will consist of one lane per one direction. After the construction of the flyover certain vehicle movements around the roundabout will no longer take place, so the resultant vehicle flow around the roundabout will look like as shown in figure12.

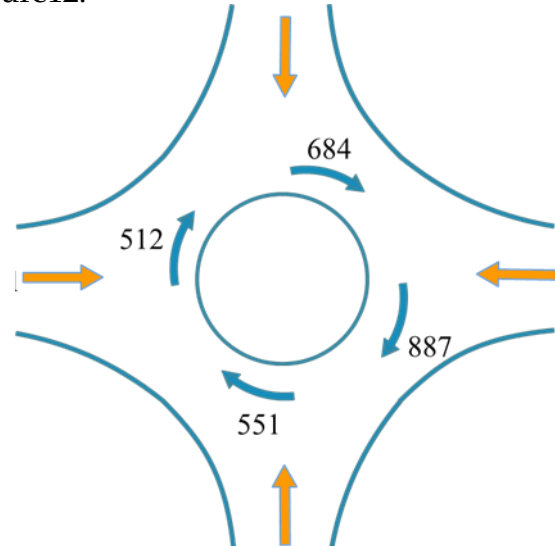


Figure 12: Traffic Flow after construction of the flyover

Capacity Check of Getambe Roundabout was performed after the flyover construction with respect to FHWA Capacity check for Roundabouts as given in table 03. Volume/Capacity ratios exceeded for the Gannoruwa road segment.

Table 03: Volume to Capacity Ratio of the Getambe Roundabout after the flyover construction

Direction of entering to the roundabout	Entry volume (Veh/hr)	Circulatory volume (Veh/hr)	Maximum Entry volume, capacity from FHWA method (Veh/hr)	Vol./Capacity Previous	Vol./Capacity Latest
Peradeniya road	632	551	900	1.22	0.78
Gannoruwa road	1131	512	840	1.67	1.35
Sirimavo Bandaranayaka road	703	684	705	1.14	0.99
William Gopallawa road	315	887	460	1.17	0.68

### 3.3 Possibilities of bypass road construction

By-pass road construction is one of the alternatives, which will explore suitable way to decrease the traffic congestion at Getambe junction. According to the Austroads classification the level of service of the road A1 is class F. This is the worst scenario where the traffic flow can be described as a moving

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car park. This can be improved by providing a by-pass road segment as shown in the figure 13.

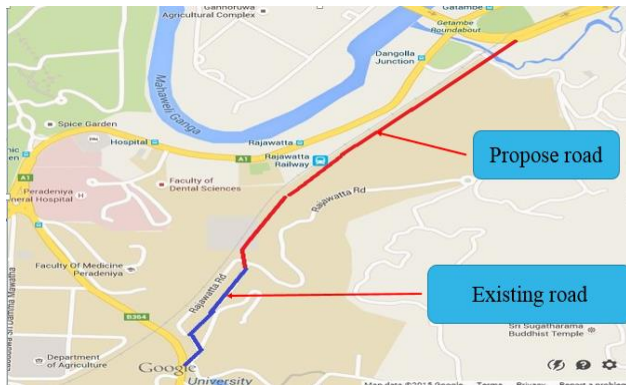


Figure 13: Proposed By-pass road

Forecasted level of service (LOS) for the A1 road segment and by-pass road segment after construction of by-pass road is found as LOS (C) and LOS (B) respectively according to the Austroads classification the level of service.

### 3.4 Widening of Getambe Roundabout

In this study, it was proposed to utilize the land around the Getambe roundabout to widen the roundabout to double lane. It is important to note that, Gannoruwa road and the William Gopallawa road are already constructed as double-lane roads. But, Peradeniya and the Sirimawo Bandaranayaka roads were constructed with the single-lane capacity. And the inscribed circle diameter for existing roundabout is 40m which was categorized under the single lane roundabout (figure 14).

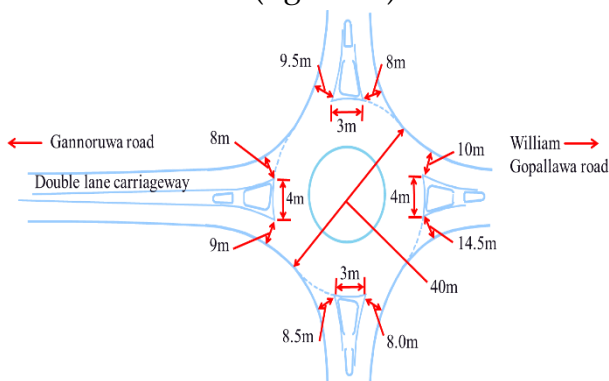


Figure 14: Existing dimensions

Proposed widening actions as shown in figure 15.

1. Inscribed circle diameter can be increased to 50 m.

2. Double lane carriage way is introduced to the Peradeniya and Sirimawo Bandaranayaka road stretches.

3. Existing double lane carriage way should be rehabilitated.

4. The bridge which was located peradeniya road stretch, should be widened to fit for double lane carriage way.

5. Entry widths, exit widths and circulatory widths were increased to fit for double lane roundabout

According to the FHWA standards, the inscribed circle diameter for double lane roundabout should be within the range of 40- 60 m. The proposed inscribed circle in this study is 50m, which is laid within the range.

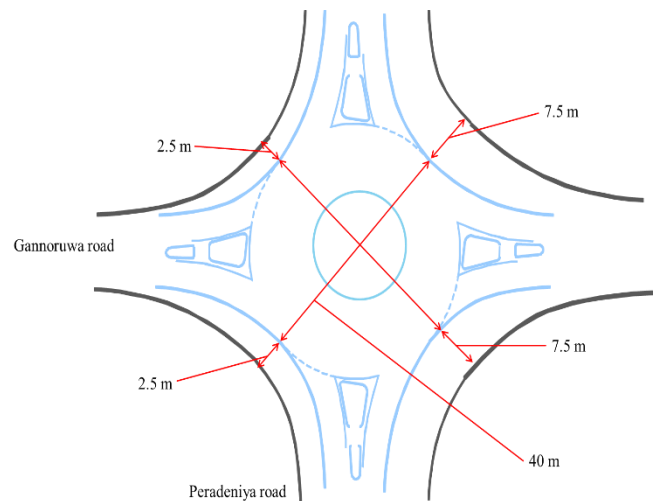


Figure 15: Proposed widening of inscribed circle diameter

More space can be utilized for widening action from the right side of the roundabout. Because there is enough space while only the limited space can be utilized from the left side. The 'Diyakapanathota Pansala' is located at the left side and maximum of 3.5m space from the existing road edge can be used for widening.

### 3.5 Possibilities of access roads improvement

As a consideration of widening of roundabout, it was proposed to introduce double lane carriage ways for both Peradeniya and Sirimawo Bandaranayaka road stretches. And also proposed fly-over has to be connected to Peradeniya leg. So it is important to highlight that the widening of

access roads such as Peradeniya and Sirimawo Bandaranayaka road stretches.

#### 4. Combinations of alternative solutions

Furthermore, all the possible alternatives were studied individually. But it is better to consider them as combinations when finding the best alternative for the traffic congestion at Getambe roundabout. In this study, two or more possible alternatives were combined and analysed separately. . It was clear, that the roundabout widening was more feasible as a solution for the traffic congestion at Getambe roundabout with minimum cost. But, for achieving more effectiveness for the mitigation measures, combinations were considered while keeping the roundabout widening as a common alternative. So, the possible combinations of alternatives are shown in figure 16.

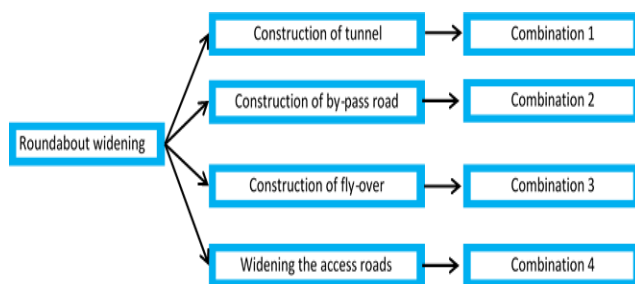


Figure 16: Possible combinations of alternatives

Based on volume to capacity ratio and Analytic Hierarchy Process (AHP), the best alternative combination was selected. Initially, all the alternatives were compared for the volume to capacity ratio and then selected combinations were checked from using AHP method. Finally best alternative combination for the traffic congestion at the Getambe roundabout was selected.

Table 04: Volume to Capacity Ratio of combinations

Entrance to the Roundabout	Volume to capacity ratio			
	Combination 1	Combination 2	Combination 3	Combination 4
Peradeniya End	0.45	1.009	0.61	0.85
Gannoruwa Rd.	0.80	1.782	0.65	1.31
Sirimavo Bandaranayake Mawatha	0.50	1.167	0.44	0.95
William Gopallawa Mawatha	0.30	1.317	0.38	0.78

Based on Volume to Capacity ratio it is obvious that Combination 2 and Combination 4 are not going to give a solution for the congestion. Combination 1 and combination 3 appear to be the most suitable solutions for the problem. Analytical Hierarchy Process is adopted to select the best out of the remaining two.

#### 5. Best alternative selection

Analytical Hierarchy Process (AHP) was used to select best alternative among the available alternative. Available alternatives are by pass road and fly over. Quantitative data was taken as the ratio measurements and qualitative data was taken as pair wise comparison. Numerical numbering system was used for the pair wise comparison and that was helped to give verbal judgment.

According to the synthesized matrix result, Final priority vector for each alternative such as by-pass road and fly over are shows in the table 05. According to the result best alternative is found as flyover.

Table 05: Priority matrix for the alternative selections

	Construction cost (0.45)	Demand (0.24)	Construction time (0.19)	Land acquisition (0.12)	Priority vector
By pass road	0.48	0.17	0.55	0.99	<b>0.48</b>
Fly over	0.52	0.83	0.45	0.01	<b>0.52</b>

As the best mitigation method for the traffic congestion at Getambe roundabout, the combination of roundabout widening and the construction of fly-over are illustrated based on volume to capacity ratio and the AHP method. When considering the roundabout widening, it should be upgraded to double lane roundabout. And the fly-over can be constructed by connecting the Peradeniya road and William Gopallawa road. This study is based on minimizing the traffic congestion at the Getambe roundabout by using this combination for the forecasting traffic flows for coming 30 years.

#### 5. Flyover design and details

A flyover is a structure used to cross another road or a railway. Flyovers are often used to

control the traffic congestion of the roads and provide smooth flow. Getambe Roundabout is a place often vulnerable to traffic congestion. Hence construction of a flyover would help to reduce the congestion and facilitate smooth traffic flow. According to the conditions and the nature of traffic flow at Getambe Roundabout most appropriate proposal is to construct the flyover from Peradeniya end of the roundabout to William Gopallawa Mawatha. Movement of vehicles to the both directions will be facilitated by the flyover and it will consist of one lane per one direction.

### 5.1 Geometric Design of the Flyover

#### Width of the Flyover

- Carriageway width ( $3.66\text{m} \times 2$ ) = 7.22m
- Median Width = 0.8m
- Shoulder Width ( $0.3\text{m} \times 2$ ) = 0.6m
- Total Width of the Flyover = 8.72m

#### Horizontal Alignment of the Flyover

Flyover should be horizontally aligned and the equations of the horizontal curves should be determined such that the curves do not disturb the vehicles to maintain the constant design speed along the curves. In the meantime the relative location of the curves should be determined considering the geographical and the relative location of the buildings and other facilities.

Minimum curvature of radius of the curve should be 60m for a design speed of 40km/hr according to "A Policy on Geometric Design of Highways and Streets" of AASHTO-1994. Radius of curvature of the flyover was taken as 100m.

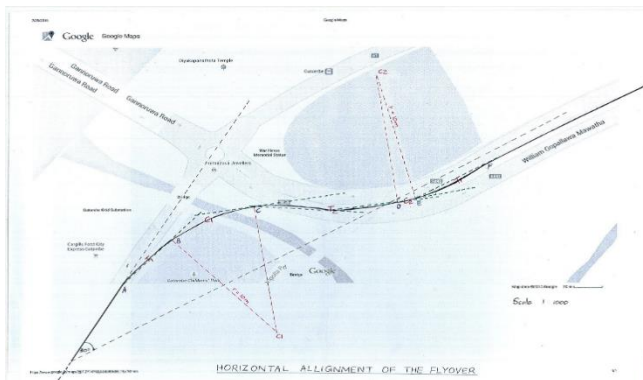


Figure 17: Horizontal Alignment of the Flyover

### 5.2 Calculation of Super Elevation

The purpose of super elevation is to facilitate the movement against the centrifugal forces exerted on the vehicles. Super elevation Rate of the flyover is found as -4%.

### 5.3 Transition Curves

When a straight curve diverts to a circular curve the radius of the curve changes from infinity to a finite value suddenly. As a result a sudden centrifugal force is exerted on the vehicle. Transition curve gradually changes its radius curvature from infinity to a finite value. So transition curves are introduced in horizontal alignment of the flyover to overcome this issue as shown in the figure. Lengths of transition curves 1 and 2 are found as 45.7 m and 91.4 m respectively.

### 5.4 Circular Curves

The basic function of circular curves is to change the direction of the movement of vehicle. In this scenario the angle between the road stretches of A1 road and William Gopallawa Mawatha is  $30^\circ$  which means a vehicle entering William Gopallawa Mawatha from A1 road diverts its direction of motion from its direction of motion at the beginning by  $30^\circ$ . Lengths of circular curves 1 and 2 are found as 58.9 m and 6.7 m respectively.

## 6. Environmental impact assessment

Findings of the EIA report indicate that some limited but significant environmental impacts will occur. For example, expropriation of land to construct the flyover will cause relocation problems. In addition, environmental health will be adversely affected to a certain extent by project implementation. While impacts to both human and environmental parameters cannot be avoided it is expected that the majority can be minimized through implementation of recommended mitigation measures and monitoring programs. The report concluded that the overall environmental impacts resulting from flyover construction and operation will be minimal if all the proposed mitigation measures and monitoring programs are properly implemented. Recognizing the



importance of the mitigation measures, the EIA report strongly recommended that mitigation measures be clearly specified in construction contracts and that qualified environmental inspectors be hired to oversee implementation of the mitigation measures during construction with their reports to be submitted regularly to the responsible authorities.

Predicted environmental impacts should be compared with the benefits of the flyover project in deciding whether the project should proceed or not. Benefits of the flyover construction identified in the EIA report included enhanced economic development through the provision of an efficient and time-saving transport system. Findings of the economic evaluation of the project as provided in the EIA report concluded that the flyover construction is economically viable.

The full-scale EIA involved in-depth analysis of baseline environmental conditions and predicted impacts on major environmental parameters. The magnitude of likely impacts was assessed and recommendations made for feasible mitigation measures and monitoring programs. It is identified probable environmental parameters which will be affected by project implementation and evaluated the likely magnitude of impacts on the identified parameters, including air and noise pollution, water quality and aquatic ecology, human resettlement, soil erosion and siltation, cultural/historical aspects, environmental aesthetics, and transportation.

### Conclusion

The purpose of this study is to review various measures that can be implemented to reduce the traffic congestion. Solutions are based on two aspects such as structural aspect and traffic management aspect. If these solutions are implemented in the study area, then considerable congestion problems will be reduced and could be made a congestion reduced traffic flow without delay and healthy environment in this area.

Considering all the traffic issues, four combinations were analysed to find out the

suitable solution along with the option of widening the roundabout into two lanes, which is a part of each combination. Four combinations; (1) Tunnel between A1 road and Sirimavo Bandaranayake Mawatha, (2) bypass road from William Gopallawa Mawatha (WPM) to Galaha road parallel to the railway track, (3) two way flyover from A1 road to William Gopallawa Mawatha and (4) improvement of access roads to the Getambe Roundabout were analysed to come up with the suitable solution. Second and forth combinations were rejected based on the volume to capacity ration of the roundabout. Out of the remaining, Analytical Hierarchy Process (AHP) was followed to select the best combination, which is the construction of a two way flyover from A1 road to WGM along with the widening of the roundabout into two lanes. Further Benefit/Cost analysis was performed to justify the selective alternative over the others.

The design of the flyover was carried out for the projected traffic of year 2045. The location for flyover was decided based on the present operating conditions. Usage of pre-stressed materials was proposed since it is economical. For the beams pre-stressed concrete, and for the piers in-situ concrete was proposed.

### Acknowledgements

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