

Delay, fuel loss and noise pollution during idling of vehicles at signalized intersection in Agartala city, India

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Abstract
Agartala, capital of Tripura, India faces traffic congestion particularly in the different road intersection due to rapid and uncontrolled development by an unacceptable level of disparity in transportation demand and supply scenario resulting in environmental degradation as well as delay and fuel loss. When the vehicles are waiting for their turn to clear the intersection, the drivers normally keep the engines of their vehicle on and unnecessary hoot horns. As a result vehicle delay, fuel loss & noise level are increased particularly at the signalized intersection. 5 (five) representative signalized intersections of varying traffic volume have been selected in this study to ascertain delay, fuel loss & noise level during idling of vehicles. The study indicates that the noise level exceeds permissible levels and vehicular delays are high as more than 60 sec/vehicle during peak hour at all important signalized intersections. The study reveals that North Gate intersection is found to be the busiest intersection as well as the noisiest intersection. In North Gate, during daytime noise level is in between 66.7 dB (A) to 108.6 dB (A) and during night time 60.4 dB (A) to 100.9 dB (A) which is ill effective on human health and environment. In Math Chowmuhani intersection fuel loss is maximum comparing to other four intersections. A direct correlation between vehicular delay versus noise level, traffic volume versus delay and traffic volume versus noise level have been proposed. These equations could be used as an effective tool in traffic management, land use planning and pollution control. After implementation of remedial measures, vehicular delay, fuel loss and noise level of all signalized intersection of Agartala city can be reduced. Delay, fuel loss and noise level at different signalized intersection of Agartala city and strategies to control the noise pollution have been discussed in this paper.
Keywords: Signalized Intersection, Average Daily Traffic (ADT), Noise Level, Fuel loss

1. Introduction

Agartala city is the capital of the state of Tripura. The city is very old and developed in 1844AD. Traffic & Transportation problems in Agartala city have not been commensurated with the increasing demands for its usage. The city expanded dynamically without any planning and control due to rapid socio-economic changes. Agartala city is the nucleus of the greater Agartala regions and all the divisional offices, educational facilities, business and shopping centers, temples, stadium etc are located in and around the city. Thus the city plays a big role in controlling the economic development not only of Agartala region but also of the entire state of Tripura. Due to lack of proper planning and control over land use activities, people from various district rush to Agartala and made it a hoard of residential, commercial and business activities. Varieties of road based transport modes catering to the transport demand ply in large numbers on the road system. As a result traffic and transportation problems are aggravating day by day. These problems are manifesting themselves in the form of increased traffic congestion, delays and subsequently causing wastage of fuels and creation of noise. . In Agartala city, all the signals at the intersection are being operated by traffic police raising their hands and “Stop”/”Go” signal is totally dependent on traffic police. When the vehicles are waiting for ‘GO’ signal at the intersection, the drivers normally keep the engines of their vehicles on and these results in extra fuel consumption. Small amount of fuel wasted, aggrevated over number of cycles per day, number of days per month and number of signalized intersections become a huge quantity. Besides, daily vehicle sidling condition in the intersection, drivers are hooting horns unnecessarily which causes more noise pollution. From traffic control point of view, study of vehicular delay & noise pollution, estimation of fuel loss at road intersection particularly in the main city or town is very important. Otherwise, in one hand traffic hazards, vehicular delay, noise pollution, fuel loss will be increased and on the other hand, level of service will be decreased in the city or town. So a study is needed with respect to vehicular delay, noise pollution, fuel loss at signalized intersection to suggest the necessary improvement of the city.This paper explains a recent fuel loss vehicular delay and noise level study on five important signalized intersections at Agartala city.

2. Scope and Objective of the Study

With this background, the objectives of the study are summarized as follows:

1. Qualification of fuel loss during idling of vehicles at selected intersections of Agartala city.
2. Estimation of Total fuel loss during idling of vehicles at the intersection.
3. Calculation of delay at different legs of intersection.
4. Measurement of noise intensity (on loudness) at different important signalized intersection of Agartala City.
5. Finding out the relation in between delay, noise level & fuel loss.
6. Implementation of improvement measures to control the vehicular delay, noise pollution & fuel loss at different important signalized intersection of Agartala city.

3. Methodology

To estimate the fuel loss, vehicular delay & noise pollution at signalized intersection in Agartala city, five intersections of varying traffic volumes were selected which were distributed all over the city. Name of the five intersections are IGM Chowmuhani, Paradise Chowmuhani, Fire brigade Chowmuhani, North Gate Chowmuhani, Math Chowmuhani. Six months study has been carried out for observation of vehicle movement at different signalized intersections of Agartala city during 14 hours daily from 7am to 9 pm. Along with this delay study, fuel loss & noise level are also observed. Sound level meter Tenmars Electronics Co. Ltd. Taiwan (IEC 61672 TYPE II) is used for measuring the noise level. Four sound level meters have been placed at a time at each arm (road) side of the intersection to take the noise level. The instrument is held in tripod stand at an average height of 1.5m from the ground level and at a distance of 3.0 m from the pavement edge with its microphone pointing towards the noise source.

For measuring fuel consumption at idling condition for each vehicle, studies were carried out by filling fuel tank of vehicle completely and then the engines were run at idling conditions. The exercise was repeated several times to determine the average fuel consumption of the vehicles during idling. The idling fuel consumption in ml/hr of different type of vehicles is given in table no1. The revenue loss of fuel for each vehicle was calculated by multiplying fuel loss with the prevailing cost of fuel. The price of petrol & diesel were taken as Rs.67.81 and Rs. 41.08 respectively in the month of July, 2012 at Agartala, India.

4.0 Results and Discussion

The traffic surveys generated data on hourly traffic volume and also the delays experienced by vehicles entering the intersection from each arm. The approaching arm wise and total traffic volume at the intersection is presented in Table 1. The hourly delays experienced by vehicles on each approaching arm are obtained by speed and delay surveys and presented in Fig. 1 to 5. The minimum delays experienced by vehicles are above 17 seconds per vehicle at all the five intersections. The delays are high as more than 60 seconds per vehicle during peak hours at all intersections. It has been worked out that on an average fuel worth Rs. 10873.00, Rs. 11979.00, Rs. 13332.00, Rs. 19175.00, & Rs. 15211.00 is wasted per day for IGM Chowmuhani, Paradise Chowmuhani, Fire brigade, Math Chowmuhani and North Gate inter sections respectively due to the delay at the intersection (Ref.Table 3). Besides, the average noise levels are calculated from the field data and tabulated in table 2 for all five important signalized intersections. The average noise level experienced by vehicles are above 65 dB(A) at all 5(five) important signalized intersection of Agartala city as shown in Fig. 6. Average Noise level of 5(five) intersections are 83.12 dB(A) and 75.92 dB(A) during daytime and night time respectively. North Gate intersection is found to be the busiest intersection as well as the noisiest intersection. In North Gate, during daytime noise level is in between 66.7 dB(A) to 108.6 dB(A) and during night time 60.4 dB(A) to 100.9 dB(A). It is evident that this noise pollution is not merely a nuisance but it is a serious environmental problem and health hazard. It is also observed that almost 99% of the drivers do not switch off their engine of their vehicles and almost 90% of the drivers unnecessarily press their horn while waiting for the signal to turn 'GO' at the intersection and resulting the increase of noise level.

A direct correlation between vehicular delay and noise level is observed at all the intersection and represented in equation 1. Regression equation of traffic volume with noise level and delay of traffic is proposed in equation2 and equation3 respectively.

Delay and noise level:

$$D = 0.786N + 0.992 \quad R^2 = 0.899 \qquad (1)$$

Traffic volume and delay:

$$V = 573.4D - 4812. \quad R^2 = 0.881 \qquad (2)$$

Traffic volume and noise level:

$$V = 479.0N - 6556 \quad R^2 = 0.893 \qquad (3)$$

Where D is Delay of Traffic in Sec/Vehicle, N is Noise level in d(BA) and V is Traffic Volume(ADT)

5.0 Measures to control delay, fuel loss and noise level at intersection

The following measures may be considered to decrease delay, fuel loss & noise pollution of traffic at the intersections.

5.1 Improper City planning and management:

Many of the cities today have grown traditionally as mono-centric cities with old narrow roads to perform the function of arterial roads. This has led to serious transportation problems, one of the key reasons being the improper city planning and management. There is consequently a need for long term urban planning which has risen from the development of integrated communities combining residential activities with industrial and commercial activities.

5.2 Introduction of High Occupancy Vehicle:

Introduction of more High occupancy vehicle (HOV) through public transport will be better and safer in respect of delay, fuel loss & noise pollution in the city as well as at different signalized intersection. HOV reduces congestion, delay, noise level and it provides more efficiently, less costly and minimal energy solution to the urban Transport problem.

5.3 Minimising Motorized Traffic & hooting of horn:

Curbing motorized traffic indirectly provides priority and preference to Non-Motorized Traffic (NMT) modes in the traffic system operation. The motorized private modes should be taxed by way of road user's charges and parking fee in the CBD area of Agartala city. In the particular zone of road intersection during idling condition of vehicle hooting a horn should be totally restricted otherwise it should be punishable by law. 'No Horn' sign may be installed in the particular zone of every intersection studying queue length of the vehicles.

5.4 Encouragement of non-motorized modes

Non-motorized modes are an essential part of the sustainable and suitable transport modal mix for the Indian cities. NMT modes being labour intensive, non-fuel dependent, free from noise are best suited for Indian Conditions and the infrastructure requirements for their operation are minimal. Special allowance can be provided as incentive to employees using non-motorized travel; these methods can lead to an improved interest among them. As a result Noise pollution as well as other pollution will be decreased in the city as well as at various intersections in the city.

5.5 Putting out engines of vehicles at traffic signals

A high percentage of noise level is at signalized intersections, this generally occurs due to the vehicles waiting to get the 'GO' signal. Due to running of engines, heavy noise and air pollution take place. Continuous awareness programs through print and electronic media is required to make the drivers aware of the harmful effects of noise pollution. A mandatory system must be followed to switch off the engines of vehicles if the waiting time is more than 14 seconds. The drivers of the vehicle need to be sensitized about the grim situation and the little contributions they can make to improve it.

5.6 Inclusion of Traffic regulations in school level curricula:

Traffic education is a very important tool in achieving the traffic discipline. Traffic education needs to be given at school level, so that the habit of following rules and discipline are indoctrinated at a very tender age. If the children are alerted of ill effects of enhanced usage of motorized modes at an early age they can extend their experience and knowledge to their parents and their future generations who in turn can optimize usage of personalized motorized traffic.

6. Conclusion

The following conclusions are drawn from the study:

- The delay of vehicle at all five important intersections is more than 60 seconds/ vehicle during peak ours of traffic.
- While waiting for the signal to turn "Go" at the intersection, almost 99% drivers do not switch off the engines of the vehicles and almost 90% of the drivers press their horns and resulting the increase of noise level.
- At five signalized intersection in Agartala 389.68 litres of diesel and 810.38 litres of petrol is wasted everyday due to idling of vehicles. Converting these figures into monetary terms the total losses work out to be Rs.61,072per day and Rs2,22,91,198.per annum.
- As per Indian standards ambient noise level in city area particularly in commercial area is in between 65 dB (A) to 55 dB (A) for day time to night time respectively. Average noise level of 5 (five) important intersection of Agartala city 83.12 dB(A) and 75.92 dB(A) during day time and night time respectively which is ill effective on human health and environment.
- The study indicates a clear correlation between noise level & vehicular delay and following equation expresses the relationship.

  $D = 0.786N + 0.992$……$R^2 = 0.899$ (4)

- The study also indicates regression equations of traffic volume with noise level and delay
  $V = 479.0N - 6556$……$R^2 = 0.893$ (5)
  $V = 573.4D - 4812$. ……..$R^2 = 0.881$ (6)
  Where D is Delay of Traffic at intersection in Sec/Vehicle, N is Noise level in dB(A) and V is Traffic Volume (ADT).
  Where D is Delay of Traffic at intersection in Sec/Vehicle, N is Noise level in dB(A) and V is Traffic Volume (ADT).
- The above equations could be used in traffic management, land use, planning, and noise pollution control.
- The traffic engineering and management measures, other measures like promoting HOV, non-motorized modes, reducing the demand for motorized modes, minimizing the practice of hooting of horn in the particular zone of intersection providing 'NO HORN' sign are very effective in reducing noise pollution. Traffic education is a very important tool in achieving the traffic discipline. Traffic education needs to be imparted at school level so that habit of following rules and discipline is inculcated at a very tender age.

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Table 1. Idling fuel consumption in ml/hr.

Sl.No.	Vehicle	Fuel Consumption (ml/hr.)	Remarks
1	Scooter	205	Petrol
2	Bike	152	Petrol
3	Car	573	Petrol
4	Car	705	Diesel
5	MCV	817	Diesel
6	Bus	930	Diesel
7	Auto Rickshaw	376	Petrol
8	Truck	1032	Diesel

Table 2. Daily traffic entering the selected signalized intersections in Agartala city

Intersection	Traffic entering from	Traffic entering (ADT)	Delay of Traffic in each arm (daily)	Total Traffic (hr)	Total Delay (hr)
IGM Chowmuhani (4-Legged)	RMS(East)	10358	181.14	30336	446.08
	Fire brigade(West)	9279	149.07		
	Music College(North)	6885	84.12		
	Paradise(South)	3814	31.75		
Paradise Chowmuhani (4-Legged)	Post Office (East)	11677	221.96	30900	470.81
	Battala(West)	9101	134.93		
	IGM(North)	6555	85.05		
	Gandhighat(South)	3567	28.87		
Fire brigade Chowmuhani (4-Legged)	IGM(East)	9779	162.17	34970	543.38
	Border Golchakkar(West)	6789	84.45		
	Ker Chowmuhani(North)	7326	97.82		
	Battala(South)	11076	198.94		
Math Chowmuhani (4-Legged)	Ramkrishna Mission (East)	11769	222.71	34791	562.57
	Motor stand (West)	10890	199.06		
	Central Jail (North)	7569	101.91		
	MBB College(South)	4563	38.89		
North Gate (4-Legged)	AIR (East)	7666	111.00	35308	613.264
	BSNL (West)	10765	194.18		
	Circuit House(North)	13456	282.65		
	Rajbari (South)	3421	25.434		

Table 3. Fuel loss at different intersection of Agartala City

Inter section	Daily Fuel loss in litres		Daily fuel loss in Rs.	Annual fuel loss in Rs.
	Petrol	Diesel		
IGM Chowmuhani (4-Legged)	130.74	50.09	10873.00	3968645.00
Paradise Chowmuhani (4-Legged)	144.67	54.12	11979.00	4372335.00
Fire brigade Chowmuhani (4-Legged)	149.37	79.93	13332.00	4866180.00
Math Chowmuhani (4-Legged)	215.76	113.37	19175.00	6998875.00
North Gate (4-Legged)	169.84	92.17	15211.00	5552015.00

Table 4. Noise level at selected signalized intersections in agartala city

Intersection	Traffic entering from	Maximum Noise Level dB(A)		Average Noise Level dB(A)
		Day Time	Night Time	
IGM Chowmuhani (4-Legged)	RMS(East)	102.5	93.5	Avg. Value (Day Time)= 78.6, Avg. Value (Night Time)= 72.4
	Fire brigade(West)	95.7	88.6	
	Paradise(South)	45.7	41.2	
	Music College(North)	70.3	66.3	
Paradise Chowmuhani (4-Legged)	Post Office (East)	108.6	93.4	Avg. Value (Day Time)= 77.9, Avg. Value (Night Time)= 69.0
	Battala (West)	93.6	85.1	
	IGM(North)	68.5	60.3	
	Gandhighat (South)	40.9	37.3	
Fire brigade Chowmuhani (4-Legged)	IGM(East)	96.0	89.6	Avg. Value (Day Time)= 86.5, Avg. Value (Night Time)= 78.5
	Border Golchakkar (West)	69.4	62.5	
	Ker Chowmuhani (North)	72.9	66.6	
	Battala(South)	107.6	95.2	
Math Chowmuhani (4-Legged)	Ramkrishna Mission (East)	108.9	100.9	Avg. Value (Day Time)= 83.8, Avg. Value (Night Time)= 77.7
	Motor stand (West)	103.3	98.7	
	Central Jail(North)	77.3	71.2	
	MBB College(South)	45.8	40.0	
North Gate (4-Legged)	AIR (East)	78.5	71.9	Avg. Value (Day Time)= 88.8, Avg. Value (Night Time)= 82.0
	BSNL (West)	101.2	94.6	
	Circuit House (North)	108.6	100.9	
	Rajbari (South)	66.7	60.4	

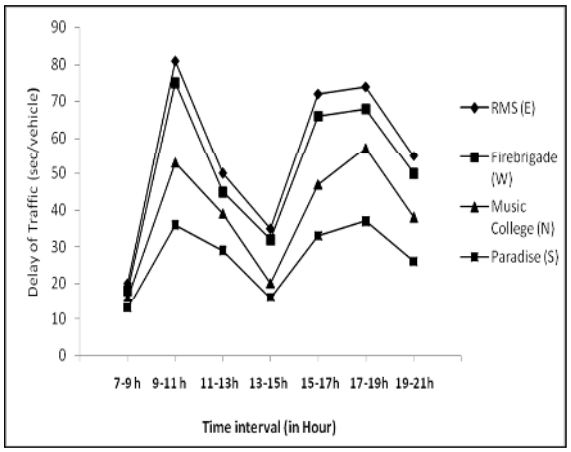

Fig 1: Delays at IGM intersection

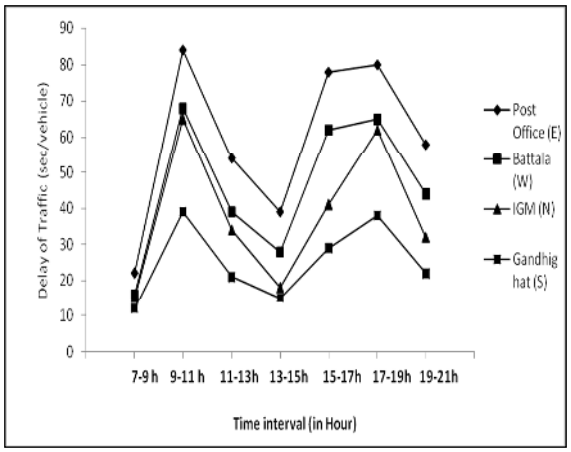

Fig 2: Delays at Paradise intersection

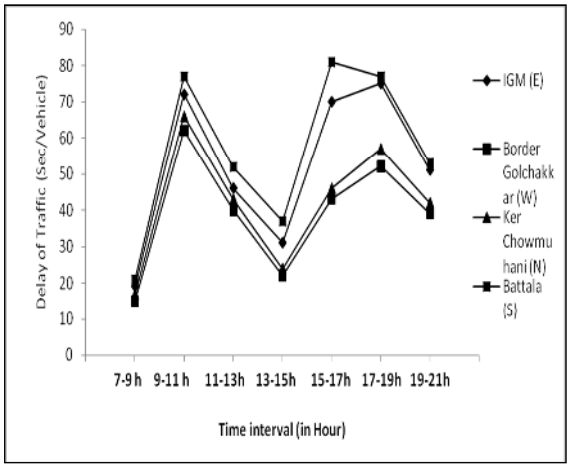

Fig 3: Delays at Fire brigade intersection

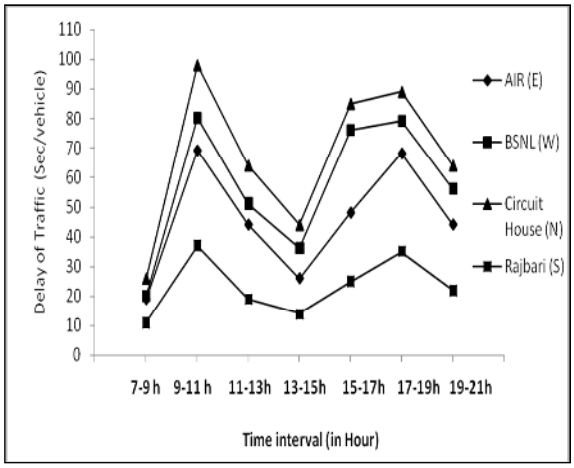

Fig 4: Delays at North Gate intersection

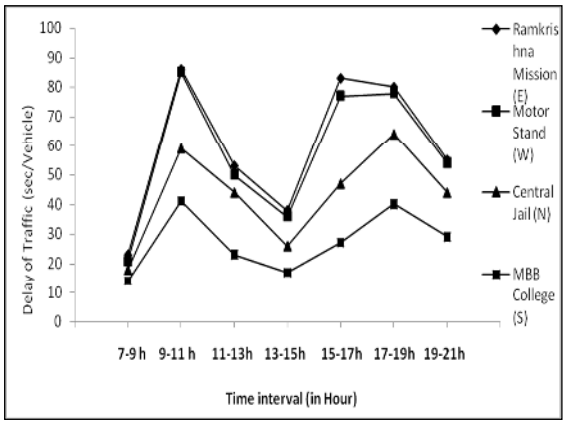

Fig 5: Delays at Math Chowmuhani intersection

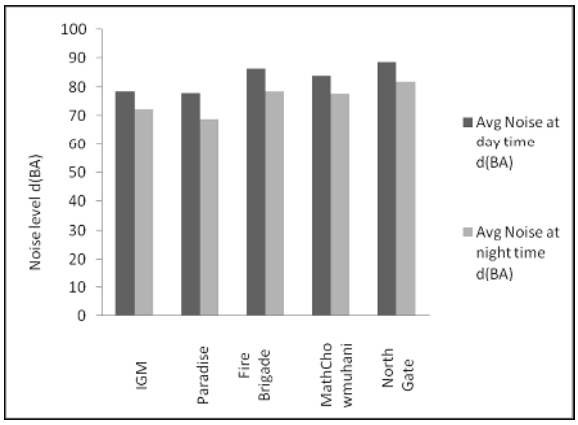

Fig 6: Noise Level at 5 intersections