

Assessment of the road characteristics of selected north–south and east–west aligned roads within Agartala Municipal Corporation, Tripura, India

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In Agartala, Tripura, India, the road network has significantly developed over the years. This study focuses on the characteristics, namely carriageway, footpath, number of lanes and roadside amenities of important east–west and north–south aligned roads, which determine the nature of traffic movement in the Agartala Municipal Corporation. The study is based on extensive field work on the level of intra-urban transport network development in the city. It reflects the presence of inadequate carriageway width, absence of footpath and sufficient roadside amenities, which results in frequent traffic bottlenecks and congestion in the city streets.

Keywords: Carriageway, median, road network, roadside amenities, traffic movement.

THE characteristics of roads determine movement dynamics, be it of people or goods. Improved geometry, design and infrastructure could help improve road safety, better flow characteristics, achieve goals of uninterrupted movement and intended operating speed¹. Also, a proper road system should be efficient, reliable, safe, economic and comfortable for the development of any region².

Road networks are rapidly changing the economic and cultural landscape of Agartala, the capital of Tripura, India. Historically, Agartala has been an important border-trading town with trading linkages with Bangladesh via its road network. Rail services through broad-gauge tracks were initiated in 2016, while air transport is expensive and not adequate for overall connectivity of the state. Consequently, road network is considered as one of the most essential modes for economic, social and commercial development of this region³.

Objectives

The three main objectives of the present study are as follows: (i) To analyse the road characteristics of east–west and north–south aligned roads in the city. (ii) To compare

the traffic characteristics with roadside amenities and land use along roads. (iii) To estimate vehicle density and delay in travel time along these roads.

Method and database

This study is entirely based on a primary survey conducted on five major east–west aligned and five major north–south aligned roads (Table 1). Traffic characteristics of the 10 selected roads have been analysed at nodal points of each of the 10 road for 1 h with 15 min interval, both during the peak hour (between 9:00 am and 10:30 am) as well as lean hour (between 2:00 pm and 3:30 pm). Congested travel time and free-flow time have been measured for four-wheelers during the peak hour and lean hour respectively on two weekdays for each of the roads. Road characteristics were estimated with the help of measuring tape, distance meter and handheld GPS. Available road amenities data were obtained through observations. Mapping was done using Arc GIS and MapInfo:10. Absence of a road map of the Agartala Municipal Corporation (AMC; either published or unpublished) was a major limitation during this study.

The following relations were used in the study:

$$\text{Vehicle density} = \frac{\text{Total traffic per hour on the roads}}{\text{Total road length}}$$

$$\text{Delay rate} = \text{Congested travel time} \\ - \text{free-flow travel time}$$

$$\text{Delay rate ratio} = \frac{\text{Delay rate}}{\text{Total road length}}$$

Road network of AMC

AMC forms a good network of roads (Table 2). National Highway (NH) 44, HGB road, Ronaldsay road and Dashamighat road intersect at Battala, the main transport nodal point of the city. It is the most congested traffic junction with high vehicular movement. The city has an

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Table 1. Selected east–west and north–south aligned roads within the Agartala Municipal Corporation (AMC)

Alignment	Road	Length (km)	Stretch
East–west	Hari Ganga Basak road	2.2	Battala–Motor stand
	Dhaleswar A.A. road	6.1	Math Chowmuhani–Khayerpur
	Akhaura road	1.2	Orient Chowmuhani–Akkhaura border
	Jail Ashram road	1.7	Ashram Chowmuhani–B.K. road
	Airport road	7.2	Lichubagan–Narsinggarh
North–south	Ronaldsay road	1.9	Battala–Durga Chowmuhani
	VIP road	4.0	North Gate–Secretariat
	Bamutiya road	7.3	Secretariat–Salbagan
	Barjala road	4.6	Durga Chowmuhani–Airport road
	National Highway NH-44	7.1	Battala–Amtali

Source: PWD, Transport Department, AMC, Agartala.

Table 2. Category of roads in AMC

Major roads	Minor roads	Roads connecting the border areas
NH-44, Hari Ganga Basak road, Dhaleswar A.A road, Ronaldsay road, Akhaura road, Jail Ashram road, Airport road, VIP road, Bamutiya road, Barjala road, ITI road, Central road and Pragati road	Netaji Nagar road, Dukli road, Kabiraj Tilla school road, Ganguli road, Hospital road, Joypur road, Ramnagar road, Jagannath Bari road and Thakur palli road	Akhaura road

Source: Categorized by the authors.

Table 3. Spatial pattern of road density

Situation of density	Nature of distribution of the wards	Percentage of wards
0–0.0002 (low)	3, 12, 13, 15, 17, 18, 19, 20, 31, 34 and 49	22
0.0003–0.0005 (medium)	5, 8, 10, 14, 16, 21, 22, 23, 24, 27, 28, 32, 35, 38, 43, 44 and 46	35
0.0006–0.0008 (high)	1, 4, 9, 8, 35, 37, 39, 40, 42, 45 and 48	22
0.0009–0.0011 (very high)	2, 6, 7, 11, 26, 29, 30, 33, 41 and 47	21

Source: Computed by the authors.

efficient rectangular pattern of road network connectivity with other parts of the state, particularly with all district headquarters.

Road density was calculated for 49 wards within AMC which comprises highways, motorways, secondary or regional roads, and other urban roads (Figure 1). Table 3 computed from Figure 1 depicts that majority of the wards have medium road density. However, it can be observed that the city centre has lesser density of roads considering its smaller dimension compared to the peripheral areas which have very high road density in some cases, attributed to their larger size and greater number of regional roads.

Road characteristics of east–west and north–south aligned roads

Road characteristics such as road length, carriageway width, median width, number of lanes, footpath along

roads, roadside drains, major and minor crossings, etc. highly influence traffic flow. An analysis of the roads characteristics was done in this study.

Carriageway

A carriageway or roadway is a width of road on which vehicles are not restricted by any physical barriers or separation to move laterally⁴. Among the selected east–west aligned roads of AMC, the carriageway width ranges from 5 m to 14 m (Table 4). The 5–8 m range includes two roads, viz. Dhaleswar A.A. road and Jail Ashram road. At present, carriageway width of Dhaleswar A.A. road is 7.5 m at Math Chowmuhani and 6.9 m at Khayerpur. Range between 8 and 11 m includes Airport road extending from Lichubagan towards Narsinggarh, whose carriageway width is 9.2 m. Within the 11–14 m range two roads, namely HGB road and Akhaura road are

Table 4. Road characteristics along selected north–south and east–west roads in the AMC

Road characteristics		Percentage of roads	
		East–west aligned	North–south aligned
Width of carriageway (m)	Less than 8	40	20
	8–11	20	40
	More than 11	40	40
Median	Present	20	60
	Absent	80	40
Width of footpath (m)	1.5–2.0	20	–
	2.0–2.5	40	40
	2.5–3.0	20	20
Width of drained cover (m)	1.50–1.78	60	40
	1.78–2.06	20	–
	2.06–2.34	20	–
No. of lane	One	20	–
	Two	80	100
Crossings	Major	31.5	47
	Minor	68.5	53

Source: Compiled by the authors from a primary survey (February–April 2017).

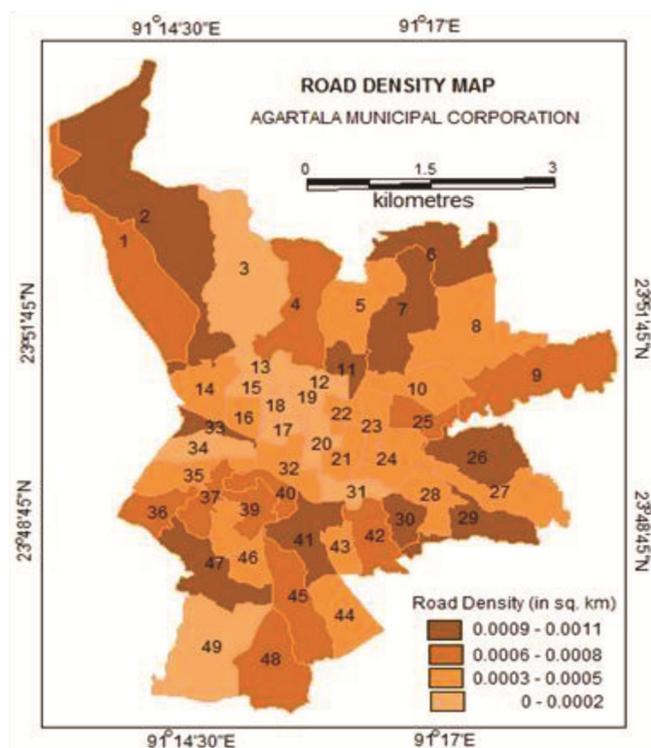


Figure 1. Road density of Agartala Municipal Corporation.

included. There is a marked variation of carriageway width among different stretches of HGB road.

Among north–south aligned roads, the 5–8 m range includes Barjala road whose present width of carriageway is 7.5 m towards Durga Chowmuhani to Kali mandir. Range from 8 to 11 m includes NH-44 and Ronaldsay road. Carriageway width of NH-44 which is 9.2 m at

Amtali increases to 26.4 m towards Battala, the main hub of the city. At this point, it physically separates into two roads between Nagerjala and Battala. Carriageway width of Ronaldsay road between Battala and Durga Chowmuhani is 8.6 m. Range between 11 and 14 m includes Bamutiya road and VIP road. Width of carriageway of Bamutiya road between Secretariat Chowmuhani and Salbagan is 25 m.

Median width

Road median is a marked area (could be a raised platform) between the dual carriageways which separate traffic flow in opposite directions. Within AMC, streets support two-way traffic and though few such roads lack medians, in most cases they are present.

Among selected east–west aligned roads, only HGB road has median between Post Office Chowmuhani and Kaman Chowmuhani, which measures 0.6 m. Medians are found along VIP road, Bamutiya road and NH-44. VIP road which supports the daily movement of state officials to and fro, has both traversable (on which vehicles can move in case of emergency) and non-traversable (a physical barrier, made of concrete or sometimes steel, in a roadway or driveway that separates vehicular traffic in opposite directions) medians⁵. Though non-traversable medians may not reduce the frequency of crashes, they can definitely help prevent a crash due to median crossover. As VIP road is important, 0.6 m raised median has been constructed from Radhanagar to Lichubagan. The width of the median has been kept small in this road to ensure expanded carriageway width, which is as high as 25 m at places. Median width of Bamutiya road is

0.54 m. NH-44, where vehicular density, frequency and velocity are high compared to other roads in the city, is inefficiently provided with a median of 0.54 m for only 1.4 km between Badarghat and Dropgate. Hence crashes are frequent along this highway. Considering the total carriageway width being 9.2 m; the small median width may be considered appropriate. However, after the completion of a flyover in 2018, 1.8 km of NH-44 has been provided with raised median.

Footpaths

Footpaths are exclusive right-of-way (ROW) to pedestrians, especially in urban areas where both the number of pedestrians and vehicular traffic is high. Minimum width of 1.5 m ensures ease of movement and may be increased based on the traffic. However, like many cities in India, many roads in Agartala lack footpaths and ensured ROW for pedestrians. Footpaths are often blocked by hawkers, particularly along HGB road, which forces the pedestrians to use the vehicular carriageway for movement. This causes congestion on the roads. The width of footpaths in the city ranges from 1.5 to 3.0 m. Among the selected roads, seven have footpaths along certain stretches. Akhaura road has a footpath on both sides between IGM and Fire Station Chowmuhani, with a width of 2.5 m. Dhaleswar A.A road also has a 2.5 m wide footpath on both sides from Math Chowmuhani to Ashram Chowmuhani. Jail Ashram road has a 2.5 m wide footpath on only one side from Dhaleswar road no. 6 to Central Jail. Airport road does not have a footpath for the entire length; yet where present, the footpath extends to 3.0 m. In VIP road, a 1.6 m wide footpath exists on the side of Astabal.

Drain cover

Proper drainage system is essential for urban areas, as it prevents roads from being flooded due to heavy rains or wastewater, thus protecting the road surface from wearing out and maintaining the carrying capacity of the roads. Majority of the roads in AMC have open drains. However, efforts have been made to use drain covers at least on major roads owing to the fact that flooding during monsoon is a recurrent phenomenon. All the selected roads of east–west alignment have drain covers, but among the selected north–south aligned roads, only two have drain covers. The present study shows that drain covers range from 1.50 to 1.78 m width at HGB road, between Battala and Kaman Chowmuhani, for Dhaleswar A.A. road between Math Chowmuhani and Ashram Chowmuhani, and for Jail Ashram road between Ashram Chowmuhani and Central jail. Akhaura road has drain cover of 1.78–2.06 m width from Fire Service to IGM, and along Airport road drain cover width ranges from

2.06 to 2.34 m. Ronaldsay road between Battala and Durgachowmuhani and NH-44 along Badarghat, Dropgate and Nagerjala have drain covers of 1.50–1.78 m width.

Nature of lanes

Selected roads within the municipal area majorly consist of two-lane roads. Except for Jail Ashram road, all the other roads of east–west as well as north–south alignment are two-lane and separated by lane markings or rubber road separators. Since Agartala does not operate intra-city bus services, separate bus bays are not designated within the two-lane roads. However, provision of rubber separators has helped in maintaining traffic within the right track, thus controlling unruly drivers creating traffic congestion.

Crossings

A place where roads intersect is referred to as a crossing or a junction. It may be major or minor depending on the vehicles plying through it. HGB road has a major crossing at Battala, the commercial hub of the city. The other four major crossings are Paradise Chowmuhani, Post Office Chowmuhani, Kaman Chowmuhani and Motor Stand. Owing to heavy traffic flow in this road, the major crossings have heavy traffic throughout the day. Quite a few minor crossing have been identified at Melarmath, Indranagar, Santipara, etc. Dhaleswar A.A. road has major crossings at Math Chowmuhani, Chandrapur Bus Stand, Ashram Chowmuhani and Khayerpur Stand. Being bus terminuses, these crossings experience heavy traffic flow. In Akhaura road, there are four major crossings at Fire Station Chowmuhani, IGM Crossing, Old RMS, Orient Chowmuhani. In Airport road major crossings are at Lichubagan and Usha Bazaar, while 14 minor crossings have been identified along this road, viz. Durjaynagar, Barjala road, Bhubanban, Usha Bazaar, Narsingarh, Singarbil, etc.

Among selected roads of north–south alignment, 47% of major crossings and 53% of minor crossings have been identified (Table 4). The major crossing of Ronaldsay road lies at Battala, Firestation Chowmuhani, Durga Chowmuhani. VIP road has four major crossings at North Gate, Astabal, Rabindra Kanan and Secretariat, and seven minor crossings. For Bamutiya road, major interconnection is at the Secretariat and minor crossings at Lichubagan, Gandhigram and Salbagan, etc. Barjala road has four identified major crossings and three minor crossings. For NH-44, the major crossings are at Hapania, Badarghat, Dropgate, Nagerjala, Battala and minor crossings are near Dukli block, Railway Station Road, Bardowali road to Ram Thakur College, etc.

Road characteristics depict developed growth of transportation infrastructure in the city. Agartala Municipal

Table 5. Roadside amenities along east–west and north–south aligned roads within AMC

Alignment	Road	Roadside amenities					
		Traffic police	Road indication board	Traffic sign	Petrol pump	Zebra crossing	Speed breaker
East–west	Hari Ganga Basak road	1	6	–	–	1	–
	Dhaleswar A. A. road	2	4	–	2	–	–
	Akhaura road	3	5	–	–	–	–
	Jail Ashram road	1	5	–	–	–	–
	Airport road	–	10	17	–	–	–
North–south	Ronaldsay road	2	12	5	–	–	–
	VIP road	5	24	51	1	6	–
	Bamutiya road	–	12	9	–	2	–
	Barjala road	–	4	–	–	–	–
	NH 44	1	6	–	2	–	–

Source: Primary survey (February–April 2017).

area has witnessed significant increase in the number of vehicles, and the developed road characteristics help expand its transport network system to meet this growing need.

Roadside amenities

Adequate roadside amenities support balanced urban transportation. HGB road being one of the main roads has several road indication boards to guide the usually heavy traffic on it (Table 5). Dhaleswar A.A. road with two traffic terminals at Motor Stand and Khayerpur is supported by two petrol pumps in its vicinity. Akkhaura road connecting the Bangladesh border to the main city has three traffic police points at Old RMS, IGM, Fire Station Chowmuhani, and five road indication boards to direct the particularly heavily loaded truck movement along the road. Jail Ashram road supporting comparatively less volume of traffic has lesser amenities compared to other roads. However, Airport road which connects to the Airport, has several road indication boards and traffic signs for smooth traffic flow.

Ronaldsay road has two traffic police points at Durga Chowmuhani and Fire Station Chowmuhani, 12 road indication boards and five traffic signs considering the usually heavy traffic on this road, particularly during office hours. VIP road, which has all the major buildings along its stretch, like the Assembly House, Secretariat Building, Governor’s residence, etc. has a total of 87 roadside amenities, including five petrol pumps of which one is a CNG station and two are BOC petrol pumps (BOC India Ltd), to ensure uninterrupted flow of traffic on it. Connecting VIP road is Bamutiya road, which is also well designed to manage traffic movement efficiently. On the contrary, Barjala road is yet to develop sufficient amenities, except for four road indication boards. NH-44 has developed sufficient amenities for efficient and incessant movement on it. It also has one CNG station along its stretch within AMC.

Traffic characteristics of AMC

Traffic flow is defined as the number of vehicles passing through a point on a road during a specified time interval. For understanding the transportation situation in the AMC area, traffic composition has been assessed through traffic count survey.

The east–west-bound roads are quite busy, supporting mainly intra-city movements. Among them, HCB road running from Battala to Motor Stand has high vehicle density (Table 6), and may be considered as the most congested road of the Municipal area. This can be attributed to its connection with NH-44 and to the 78% commercial land use along the entire stretch of the road, including the hawkers’ corner. Dhaleswar A.A. road between Math Chowmuhani and Khayerpur continues to connect Shilong–Agartala–Sabroom road and depicts high up and down traffic movement. However, it is different from HCB road because many more auto rickshaws and two-wheelers ply along the road. Akkhaura road between Orient Chowmuhani and Fire Station covers 50% area under schools, state library, government offices, court and hospital, subsequent stretch along this road has ministers’ quarters, and thus the number of personalized vehicles is much higher along this road. This road also supports movement of heavy vehicles like trucks, being connected to Akkhaura border in Bangladesh. Though both Jail Ashram road and Airport road have less vehicle density, that of Jail Ashram road is significantly high, whereas it is as low as 91.1 for Airport road. Since Airport road runs almost along the Bangladesh border, both residential as well as commercial activities are much less.

Even though north–south aligned roads, particularly NH-44, carry high volume of inter-city traffic, the average vehicle density is lower than the east–west aligned roads. In Ronaldsay road, a large number of intermediate transport modes like auto-rickshaws and toto ply as it intersects two major east–west aligned roads, i.e. HCB road

Table 6. Vehicle density of selected roads in AMC

Alignment	Road	Total number of vehicles	Length of road	Vehicle density
East–west	Hariganga Basak road	6471	2.2	2941.3
	Dhaleswar A.A. road	3166	6.1	519.0
	Akhaura road	2627	1.2	2189.1
	Jail Ashram road	1996	1.7	1174.1
	Airport road	656	7.2	91.1
North–south	Ronaldsay road	3596	1.9	1892.7
	VIP road	4267	4.0	1066.7
	Bamutiya road	2987	7.3	409.1
	Barjala road	2593	4.6	563.6
	NH-44	5588	7.1	787.0

Source: Compiled by the authors from the primary survey (February–April 2017).

Table 7. Delay rate of selected roads in AMC

Alignment	Roads	Direction	Congested travel time	Free-flow travel time	Delay rate	Delay rate ratio
East–west	Hariganga Basak road	Up	13	10	3	1.36
		Down	13	9	4	1.82
	Dhaleswar A.A. road	Up	17	14	3	0.49
		Down	16	12	4	0.66
	Akhaura road	Up	7	6	1	0.83
		Down	5	4	1	0.83
	Jail ashram	Up	6	4	2	1.18
		Down	6	4	2	1.18
	Airport road	Up	19	18	1	0.14
		Down	19	20	1	0.14
	Ronaldsay road	Up	11	9	2	1.05
		Down	12	8	4	2.10
	VIP road	Up	13	9	4	1
		Down	10	9	1	0.25
Bamutiya	Up	10	10	0	0	
North–south	Road	Down	11	10	0	0
	Barjala road	Up	9	8	1	0.22
		Down	11	9	2	0.43
	NH-44	Up	24	18	6	0.85
		Down	24	18	6	0.85

Source: Computed by the authors from the primary survey (February–April 2017).

and Akhaura road. VIP road depicts high flow of traffic, mainly personalized ones because most of the government offices are located along it. This is also a reason why congestion is comparatively well managed and free flow of traffic remains almost throughout the day. Bamutiya road also supports high traffic volume, mostly inter-city traffic, since it is directly connected to Khowai. Barjala road directly intersects Airport road and therefore a significant number of private and public vehicles move along this road both during peak as well as lean periods. Along NH-44, average movement of vehicles is quite high even during the lean period, since this is the only main road for any movement to the southern part of the

state. However, vehicle density along this road remains comparatively low due to its large stretch.

Traffic movement along selected roads

After assessing the traffic characteristics in each of these roads, an assessment was made of the nature of movement along them. For this, delay rate ratio was calculated for each of the ten selected roads. HGB road being the most busy and congested, showed the highest delay rate among the east–west aligned roads, whereas Airport road showed the least value (Table 7), the total number of

vehicles plying on this road is one-tenth of that on HGB road.

Among the east–west aligned roads, Ronaldsay showed very high delay rate ratio, since it intersects with the office lane and has two auto-rickshaw stands on its entire stretch. Bamutiya road showed more or less free flow during both peak and lean periods.

After analysis of transport movement in AMC, it can be concluded that transport density mostly depends on factors such as road infrastructure, type of vehicles, roadside land use, etc.

Conclusion

The number of vehicles plying on the roads of AMC is on the rise. Most of the roads have narrow carriageway and majority of them have extensive commercial or residential areas which create problem in acquiring land for increasing road space. Personalized and intermediate modes of transport dominate the traffic composition. In case of streets with lower traffic movement, pedestrian footpaths have lost significance (Barjala road). Traffic intersections are still manually operated in almost all roads. Insufficiency of roadside amenities (like speed breakers, zebra crossings, petrol pumps, road indication boards, traffic signs and traffic police points) is another notable issue. Thus major congested roads like HGB road, NH-44, Akhaura road and Ronaldsay road have high vehicle density, high delay rate ratio, greater chance of road accidents and parking difficulties. Authorities are taking efforts to improve the quality of these roads as well as increase connectivity with other parts of the state. Currently, construction of a flyover over congestion-prone roads for

reducing travel time, easy transport of commodities and people is being undertaken. Therefore, enhancement of road space and provision for dual carriageway or single carriageway roads, with high capacity junctions would be a good solution for the city.

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ACKNOWLEDGEMENTS. We thank the Department of Geography and Disaster Management, Tripura University for providing the necessary facilities for this study. We also thank the students for help during field surveys.

Received 30 August 2019; revised accepted 4 March 2020

doi: 10.18520/cs/v119/i1/112-118