Level of Service (LOS) Effect in Terrain Conditions

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Abstract- ***The Road Traffic flow is a process that which involves the interaction between road facility, vehicles and characteristics of road users. The stochastic nature of traffic stream flow gives random variations in vehicles, user characteristics and their interactions. Further, traffic stream characteristics also changes due to variations in design of road facilities. Level of Service (LOS) applied for quantitative measure to represent quality of service provided by road facility varies between Levels of Service "A" through "F" where, LOS'A' represents the highest and LOS'F' representing the lowest. Though Highway Capacity Manual presented the level-of-service concept for highway capacity analysis, with Capacity and flow as parameters for measuring LOS, but with minor changes later speed, density, headway, spacing etc. have also been used for evaluating LOS. However, the concept of LOS is presently applicable only to plain terrain conditions but not rolling terrain. Therefore, the standard conditions cannot be applied for all terrains and LOS need to be assessed for Terrain having more than 2% gradient and demographic conditions where higher levels of roads such as Highways and freeways are not provided. This paper represents the study of roads carried out in Port Blair, the capital of Union Territory of A&N Islands, to compare LOS for the prevailing the gradient and capacity with the LOS levels recommended by various Standards***

Index Terms- LOS, V-C Ratio, Modal Speed, Geometric Standards

I. INTRODUCTION

The Highway Capacity Manual (HCM) presented the concept of level-of-service for highway capacity analysis. The operational analysis applied both operating speed and Volume to capacity (v-c) ratio for evaluating LOS of two-lane highways. Thus, the capacity analysis established six LOS, A to F, to represent quality of highway operations. It recommended that LOS "A" represents the best road traffic condition for free flow speed, and on the other hand LOS "F" represents the highly congested flow with traffic exceeding capacity of roadway facility.

Subsequently, US-HCM 2000 also used a flow rate of 2200 Passenger Car Units (PCU)/hour/lane for assessing LOS of a multilane highway. It varies in the range of 2000 to 2300 PCUs / hour/ lane for a four – lane highway in many European countries. In India, a maximum capacity range of 3600 to 6000 PCUs /hour is used for urban roads (IRC: 86-1980). Therefore, parameters such as volume and speed in between these ranges defines LOS from A to F. The range of capacities used for non-urban roads or rural roads (IRC :73-1980) is between 5000 to 20000 PCUs /day. However, these allocations of capacities are applied only for roads in plain terrain having ruling gradient not more than 2%. These roads also follow standard space in terms of geometrics for ideal operational condition. In addition to this other parameter such as safety, road and vehicular characteristics, user behavioural aspects etc., were also used to compute and designate LOS for different conditions of highways and urban roads.

II. STUDY AREA

A study was carried out on road network in Port Blair, the capital town of union territory (UT) of Andaman & Nicobar Islands. The Andaman & Nicobar Islands is situated in Bay of Bengal having (Fig-.1) a total geographical area of 8300 Square kilometers. Port Blair has an area of 16.64 square kilometers

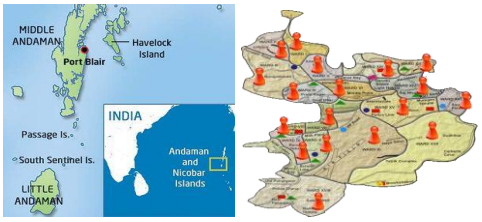

Fig. 1- Location of Andaman & Nicobar Islands and Port Blair.
(Source – www. mapsofindia.com)

The irregular pattern of Road work in Port Blair is due to terrain conditions, growth pattern and topography of the area. Totally, eight roads were selected in the study area for the present work. These selected roads are Modal School Road, Kamraj (also known as VIP) Road, Middle point Road, Bengali Club Road, Pheonix Bay Road, Delanipur Road, Junglighat Road and School Line (VKV) Road. The geometric details are given in Table 3.1

Table 3.1 – Geometrical details of Selected Roads

SN	Name of the Road	Distance length from Intersection in Km	Average Width of Carriageway (meters)	Whether meeting Intersection at Grade
1	Modal School Road	0.3	8.9	At Grade
2	Kamraj Road (VIP Road)	1.6	9.46	Grade Separated
3	Middle Point Road	0.6	13.45	At Grade
4	Bengali Club Road	0.2	10.95	Grade Separated
5	Pheonix Bay Road	1.0	9.95	Grade Separated
6	Delanipur Goalghar Road	0.7	7.52	Grade Separated
7	Junglighat Road	1.1	12	Grade Separated
8	School Line (VKV) Road	1.5	12	At Grade

The intersection in most of these roads is spaced at less than 1 km interval. Also, the built-up spaces along road margins reduce effective width of roads. The total area occupied by roads is 140 hectares i.e. 8% of total area. Also, the total road length in Port Blair is only 65 Km. Moreover, all the selected roads have single carriageway system with varying gradient as well as two-way traffic provision

III. PROJECT INVESTIGATION

Traffic Count was taken for measuring Composition of vehicles, Traffic flow, capacity and Average Daily Traffic (ADT). The traffic census was carried out manually for the present work as per the guidelines prescribed byIRC: 9-1972. Further, selected roads were divided into sections. Care has been taken to avoid points causing substantial changes in traffic flow. The count was taken for 12 hours including peak and off-peak hours. Also, traffic count was obtained for both peak (September to February) and off-peak tourist season (March to August) of the year. Further, the Passenger Car Equivalency factors were taken as 0.75, 1, 2, 3.7 and 0.5 for two wheelers, passenger cars/four wheelers, Auto-rickshaws, Bus/truck and cycles respectively (IRC:106 -1990). Thus, obtained classified volume was converted into Passenger Car Units (PCUs) . The Average Daily Traffic obtained for the selected roads in the present work is given in Table 3.1 to Table 3.8.

IV. TRAFFIC CAPACITY

The capacity of the roadway is the maximum number of vehicles that can pass a given point on a lane in roadway during one-hour period. The nearly ideal roadway and traffic conditions are considered for computing theoretical/basic capacity. Further, roads in present study have similar physical features with respect to geometric standards. Therefore, theoretical capacities were evaluated for the eight selected roads.

Further, the average spacing between center to center of vehicles was measured as equal to the average length of vehicles plus the clear spacing between the vehicles in the stream.

Further, the modal speed from Spot speed survey and a reaction time of 2 seconds was considered for computing Spacing of vehicles in all roads in present work. However, based on the composition of vehicles,

5.3 m was taken as average length of vehicle. Thus, theoretical capacity was computed lane wise. Further, the flow count was taken for lanes and Volume Capacity (v-c) ratio was determined. The measured capacity and v-c ratio of road network are given in Table 4.1

Table 4..1 Volume Capacity (v-c) Ratio of Road Network

Name of the road	Direction of Flow	Theoretical Capacity (C=1000V/S) veh/hr/lane	Hourly Volume (Veh/Hr)	v-c Ratio
Model School Road	towards Clock tower	1364	1345	0.99
	towards Bengali Club	1437	1399	0.97
Kamraj Road	towards IP&T	1451	1394	0.96
	towards Secretariat	1477	1161	0.70
Middle Point Road	towards Goalghar	1477	1065	0.72
	towards Bengali Club	1483	1186	0.80
Bengali Club Road	Towards Light House	1483	1602	1.03
	towards Bengali Club	1483	1160	0.78
Pheonix Bay Road	Towards Light House	1451	998	0.69
	towards Delanipur	1477	891	0.60
GoalgharDelanipur Road	towards Delanipur	1477	1117	0.76
	towards Goalghar	1477	1068	0.76
Junglighat Road	towards Goalghar	1421	1320	0.93
	towards Dairyfarm	1477	1522	1.03
School Line Road	towards school Line	1421	1069	0.75
	towards Dairyfarm	1421	1549	1.09

V. TRAFFIC SPEED

The heterogeneous traffic in roads of study area gives varying speed. Therefore, Modal Speed was computed for all eight roads in present study using spot speed. The Modal Speed was considered for both directions and then higher speed values were considered for LOS evaluation.

As per IRC: 86-1983, the design speed for urban roads should be 80,60,50 and 30Kmph for Arterial Road, Sub-arterial, Collector Street and Local Street respectively. Accordingly, all roads in the study area have to be categorized as only local streets, but not arterial road. Though, Kamraj Road complies with through traffic and continuity as per IRC standards to categorize as arterial road, the Modal speed for this road was found to be only 44 Kmph. It is very much less than 80 Kmph prescribed by IRC for Arterial Roads. Even, other seven roads in the present study area with frequent intersection, cannot be considered as arterial roads inspite of showing same mobility as of Arterial road due to low modal speed. However, all these roads fulfill the conditions to be categorized as Downtown roads with frequent intersections (HCM, 1985). Further, HCM has suggested speed as a criterion to measure the LOS. The LOS based on Speed as suggested by HCM is given in Table 5.1

Table 5.1 LOS based on Speed as per HCM

SN	Name of the road	Modal Speed (Kmph)	LOS as per Speed for Down town roads (HCM 1985)
1	Modal School Road	38	B
2	Kamraj Road	44	A
3	Middle Point	45	A
4	Bengali Club	45	A
5	Pheonix Bay Road	44	A
6	Delanipur–GoalgharRoad	44	A
7	Junglighat Road	44	A
8	School Line Road	36	B

It is evident from the result that the Modal Speed of all eight roads (Modal School Road, Kamraj Road, Middle point Road, Bengali Club Road, Pheonix Bay Road, Delanipur Road, Junglighat Road and School Line Road) were in the range of36 Kmph to 45 Kmph. The Modal School road and School Line road have shown relatively less modal speed of 38 and 36 Kmph respectively than other road showing either 44 or 45 Kmph. The relatively less modal speed in Modal School and School Line school roads is because of frontage usage due to parking of vehicles and high commercial activity. However, higher gradients of other roads improved modal speed as these roads are free from frontage usage.

t is evident from the table that all roads in study area except

Modal School Road and School Line Road can be designated as LOS "A" for the prevailing operating speed

VI. VOLUME CAPACITY RATIO

The Volume/Capacity Ratio (V-C ratio) directly indicates the level of congestion and corresponding level of service. Further, both the Pheonix Bay Road and Delanipur, having v-c ratio of 0.6 and 0.7 respectively, are exhibiting Level of Service A as per HCM (1985) standards. But, all other roads having v-c ratio in the range of 0.8 to 1.09, are indicating unstable flow with LOS "D" or "E". However, as per IRC:106-1990, the road with v-c ratio in the range of 0.5 to 0.7 indicates stable flow with LOS –C.

Further v-c ratio of 1.0 and beyond 1.0 gives forced flow (IRC:106-1990). Therefore, thev-c ratio and speed give varying LOS for roads in present study area. The LOS of roads based on v-cratio as per IRC is furnished in Table 6.1

Table 6.1 Volume Capacity (v-c) Ratio and LOS of Roads

SN	Name of the road	v-c Ratio	LOS as per capacity (IRC 106-1990)
1	Modal School Road	0.9	D
2	Kamraj Road	0.8	D
3	Middle Point	0.8	D
4	Bengali Club	1	E
5	Pheonix Bay Road	0.6	C
6	Delanipur–Goalghar Road	0.7	C-D
7	Junglighat Road	1.03	F
8	School Line Road	1.09	F

It is evident from the result that Pheonix Bay Road and Delanipur road are exhibiting stable flow as per IRC-106,1990. Further, Bengali Club Road, Junglighat Road and School Line Road are showing forced flow. But, Modal School Road, Kamraj Road and Middle Point Road are demonstrating unstable flow. Further, IRC (IRC:106-1990) recommends that LOS C,with the volume of traffic 0.7 times the

maximum capacity, should be considered for urban roads. Thus, as per IRC, most of the roads in present work is indicating maximum capacity.

VII. CONCLUSION

The volume of traffic in the study area varies in the range of 891 to 1602 PCU/Hr. The traffic volume in the study area is higher than the range prescribed by IRC for urban road network with intersections. Nevertheless, the prevailing flow is offering congestion free traffic. Even, traffic flow rate vary significantly in the range of 555 to 1425 Veh/Hr. The Modal Speed of road network vary in the range of 36 to 45 Kmph. It is far less than the design speed prescribed by IRC for two lane urban roads. The less modal speed in the study area is due to non-compliance of geometric standards prescribed by IRC in the urban roads..Based on the prevailing operating speed, facility service in all roads in study area, can be designated as LOS "A", except Modal School Road and School Line Road. The Modal school and School line roads exhibiting LOS"B".

Both Pheonix Bay Road and Delanipurroad, having v-c ratio of 0.6 and 0.7 respectively, are exhibiting Level of Service C as per IRC: 106-1990. But, all other roads having v-c ratio in the range of 0.8 to 1.09, are showing LOS "D" or "E". However, as per HCM (1985) standards, these roads are demonstrating Level of Service A. This indicates that v-c ratio and speed are giving varying LOS for same road network in present study area.

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