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Assessing Level of Service for Highways in a New Metropolitan City

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***Abstract*—The Level Of Service is a qualitative measure describing operational conditions within a traffic stream, and their perception by drivers or passengers. The present research primarily aims at analyzing the level of services for different highways of a new metropolitan city using HCS-2000. Continued efforts are being focussed towards the assessment of Level Of Service at intersections, although it is necessary to assess the Level of Service at highway mid-block sections. The research presented here mainly aims at assessment of the level of service at highway midblock sections. The field survey is carried out to capture the traffic volume as well as the corresponding average spot speed of traffic through manual as well as videography technique. The level of service F is not observed anywhere since tha analysis is carried out at the mid block sections rather than at the intersections.**

Keywords—Level Of Service; Volume To Capacity Ratio; Average Spot Speed; Videography Technique.

INTRODUCTION

Metropolitan cities in India are witnessing for very high rate of population growth, consequently the rise in traffic in their transport corridors. The concern about the deterioration in the LOS is due to the uncontrolled growth of vehicular traffic volume, shortfall of supply side of transportation capacity, resulting in the additional delay, extra fuel consumption, user cost etc. Therefore it is necessary to assess the level of service of highways passing through the metropolitan cities over a period of time in order to adopt the various transport improvement programmes on short as well as long term basis for improving the level of service. In most of the cases , performance of the highway is expressed in terms of level of service, which is a method proposed to illustrate traffic conditions for an existing or proposed transportation facility operating under current or projected traffic demand. The highway capacity manual (HCM) defines highway level of service as a "a qualitative measure describing operational conditions within a traffic stream, as perceived by the motorists"[Transportation Research Board (TRB) 2000]. Level of Service describes these operating conditions in terms of the parameters such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, convenience and safety.The six level of services are proposed in the latest version of the HCM ranging from A to F, with A representing best operating condition [Free Flow] and F as worst [Forced flow or breakdown flow].The assessment of the level of service using the speed and volume to capacity ratio as the measure of effectiveness has been demonstrated through the application of HCS-2000 software for three different highways. The objective of this research is the identification and analysis of highway level of service in relation to avg. spot speed and corresponding traffic volume. A lot of research work is carried to assess the level of service at the intersections but very less research work is carried out to assess it at mid block sections, so it is necessary to assess the level of service at highway mid block sections so that the improvement in the level of service at mid blocks will automatically reflect in the improvement in the level of service at the intersections.

Antony Stathopoulos [1] proposed an approach for estimating the duration of congestion on a given road section and the probability that, given its onset, the congestion will end during the following time period. . Rahman et. al. [2] developed a model for LOS using passing-overtaking manoeuvres in terms of total traffic volume and percent of rickshaw. M.V.LR Anjaneyulu et.al. [3] studied the relationship of congestion with speed variation and quantified the congestion using speed variation also he defined the 5 Level of Services from A to E based on the coefficient of variation of speed. Chetan R. Patel [4] proposed an empirical investigation in the behavior of mixed traffic stream speed and flow rate on an access controlled urban arterial in Surat city in Gujarat state of India. Eleonora Papadimitriou [5] analyzed the perceived highway level of service in relation to drivers personal characteristics and traffic conditions. The results confirm that the relationship between perceived level of service and traffic conditions has a piecewise linear form with significant differences in slopes and breakpoints. Milica Selmic [6] developed a model for the best strategy selection

from transportation and drivers point of view for transportation demand management aimed to reduce the congestion. Ning Wu et.al. [7] developed a model which takes into account the total segment of freeway merge diverge and weaving as an entire object. A combined volume-capacity ratio is used for determining the LOS of the total sections. Indrajit Ghosh [8] summarized the evolution on the research of determining the level of service of two lane roads and provide discussion for future directions pertinent to Indian mixed traffic situation. Takashil Sakai et.al [9] proposed a simplified method for measuring driver satisfaction (CS) in real time with observable data and proposed six level of services in accordance with HCM based on the customers satisfaction. Maitra et. al. [10] proposed development of LOS criteria based on congestion, 10 levels of service have been proposed depending upon the percentage of congestion, with 9 in stable zone as A-E, and one representing an unstable operation as F. The model is applicable to undivided urban streets with relatively high proportions of rickshaws. In this context, present study is carried out to determine the flow behaviour under mixed traffic conditions and also to establish LOS for the prevailing traffic conditions.

METHDOLOGY

Three highways (MSH-248, MSH-255, MSH-260) were selected for assessment of level of service. Level of service of each highway section is assessed by using HCS-2000 Software. Traffic surveys are conducted to collect the data of vehicular volume and speed on the selected road sections for different highways passing through the metropolitan city. Inventory surveys are carried out for gathering the primary information regarding road surface characteristics, number of lanes, lane width etc. On the basis of inventory surveys the detailed surveys are planned. The surveys are conducted on normal working days during morning and evening peak as well as off peak hours covering wide range of traffic conditions and flow behaviour.

Table 1: Roadway Features and Data Collection Techniques.

Name of road (1)	Number of lanes per direction (2)	Carriageway width per direction (m) (3)	Surface type (4)	Data Collection technique (5)
MSH-255	2	7.48	Bitumen	Videography
MSH-248	2	7.50	Bitumen	Videography
MSH-260	3	10.42	Bitumen	Videography

About the HCS-2000

The Highway Capacity Software (HCS-2000) adopts the procedure given in the Highway Capacity Manual (HCM-2000) for analyzing roadway capacity and determining level of service (LOS) for signalized intersection, urban roads (Arterials), freeways, Multilane highways. The Level of services for different highways are computed by using the HCS-2000 software. The level of services are computed for morning peak periods as well as morning off peak periods, However the variation of avg. spot speed against volume is depicted by the graphs.

Table 2: Level of Service for MSH-248 (Morning peak hour)

Time interval (Min.)	Flow (q) (PCU/hr)	Avg.Spot speed (Km/hr)	Density (k) (PCU/km/ln)	LOS as per HCS-2000
0-5 min	2688	40.91	66	D
5-10 min	2736	39.82	69	D
10-15 min	2364	45.37	53	D
15-20 min	2364	45.37	53	D
20-25 min	2448	44.06	56	D
25-30 min	2808	38.72	73	E
30-35 min	2460	43.93	56	D
35-40 min	2232	47.56	47	D
40-45 min	2472	43.28	58	D
45-50 min	2376	44.58	54	D
50-55 min	2256	47.34	48	D
55-60 min	2328	46.51	51	D

Table 3: Level of Service for MSH-248 (Morning off peak hour)

Time interval (Min.)	Flow (q) (PCU/hr)	Avg.Spot speed (Km/hr)	Density (k) (PCU/km/ln)	LOS as per HCS-2000
15-20 min	2088	50.55	42	C
20-25 min	2640	41.08	65	D
25-30 min	2292	46.85	49	D
30-35 min	1920	51.42	38	C
35-40 min	2208	48.02	46	D
40-45 min	2256	47.34	48	D
45-50 min	2076	50.69	41	D
50-55 min	1932	51.34	38	C
55-60 min	2184	48.20	46	D
0-5 min	2268	47.09	49	D
5-10 min	1980	51.09	39	C
10-15 min	2160	49.21	44	D

Table 4: Level of Service for MSH-255 (Morning peak hour)

Time interval (Min.)	Flow (q) (PCU/hr)	Avg.Spot speed (Km/hr)	Density (k) (PCU/km/ln)	LOS as per HCS-2000
0-5 min	2412	36.87	66	D
5-10 min	2436	36.50	67	D
10-15 min	1920	41.05	47	C
15-20 min	2136	40.18	54	D
20-25 min	2724	36.04	76	D
25-30 min	2460	36.33	68	D
30-35 min	3240	32.39	101	E
35-40 min	3120	33.41	94	E
40-45 min	2844	35.00	82	E
45-50 min	3096	34.10	91	E
50-55 min	2340	37.09	64	D
55-60 min	2148	39.58	55	D

Table 5: Level of Service for MSH-255 (Evening off peak hour)

Time interval (Min.)	Flow (q) (PCU/hr)	Avg.Spot speed (Km/hr)	Density (k) (PCU/km/ln)	LOS as per HCS-2000
0-5 min	1404	47.81	30	C
5-10 min	1152	49.55	24	B
10-15 min	1572	46.93	34	C
15-20 min	1236	48.59	26	B
20-25 min	1716	44.02	39	C
25-30 min	1560	47.03	34	C
30-35 min	1488	47.46	32	C
35-40 min	2064	40.89	51	D
40-45 min	1872	41.68	45	C
45-50 min	1596	46.20	35	C
50-55 min	1524	47.21	33	C
55-60 min	1620	45.98	36	C

Table 6: Level of Service for MSH-260 (Morning peak hour)

Time interval (Min.)	Flow (q) (PCU/hr)	Avg.Spot speed (Km/hr)	Density (k) (PCU/km/ln)	LOS as per HCS 2000
0-5 min	1212	47.58	26	B
5-10 min	1416	46.82	31	C
10-15 min	1284	47.43	28	B
15-20 min	1824	41.44	45	C
20-25 min	1752	42.59	42	C
25-30 min	1632	44.00	38	C
30-35 min	1644	43.87	38	C
35-40 min	1632	44.00	38	C
40-45 min	1692	43.39	39	C
45-50 min	1644	43.87	38	C
50-55 min	1908	40.97	47	C
55-60 min	1752	42.59	42	C

Table 7: Level of Service for MSH-260 (Morning off peak hour)

Time interval (Min.)	Flow (q) (PCU/hr)	Avg.Spot speed (Km/hr)	Density (k) (PCU/km/ln)	LOS as per HCS 2000
0-5 min	1488	46.06	33	C
5-10 min	1596	44.55	36	C
10-15 min	1344	47.00	29	B
15-20 min	1284	47.43	28	B
20-25 min	1800	41.69	44	C
25-30 min	1440	46.59	31	C
30-35 min	1512	45.11	34	C
35-40 min	1452	46.46	32	C
40-45 min	1608	44.09	39	C
45-50 min	1488	46.06	33	C
50-55 min	1320	47.09	29	B
55-60 min	1620	44.05	37	C

Generalized Relationship Between Different Flow Parameters

The relationship between the various flow parameters (speed, flow, density) for MSH-248 is depicted here. The Speed will decrease with increase in traffic volume. As the flow increases the density will increase.

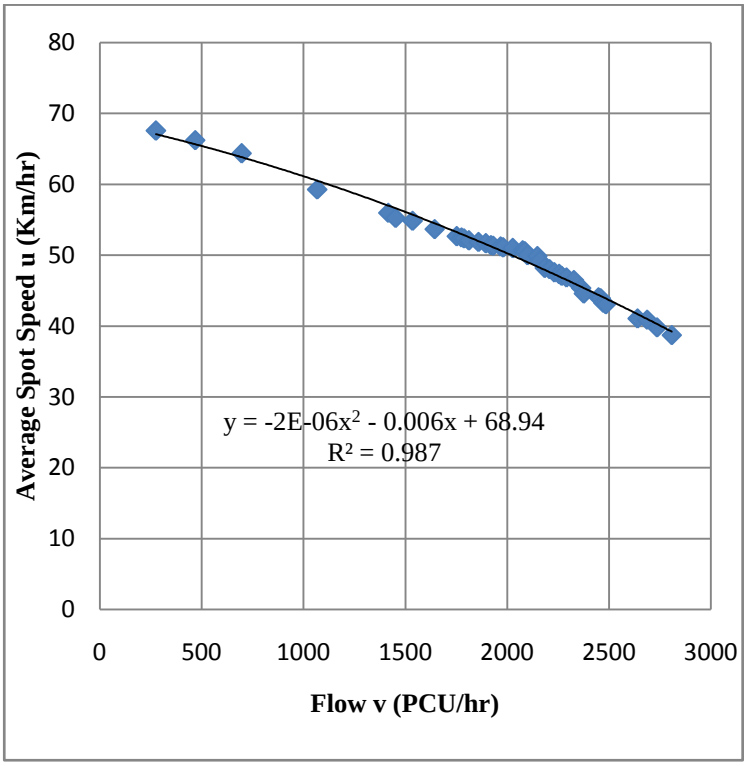

Fig.1 Variation of Average Spot Speed with Flow

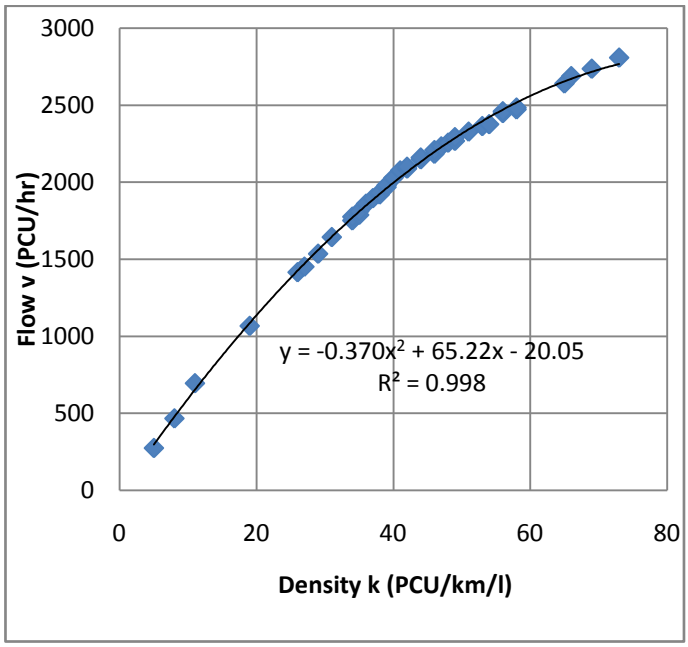

Fig. 2 Variation of Flow with Density.

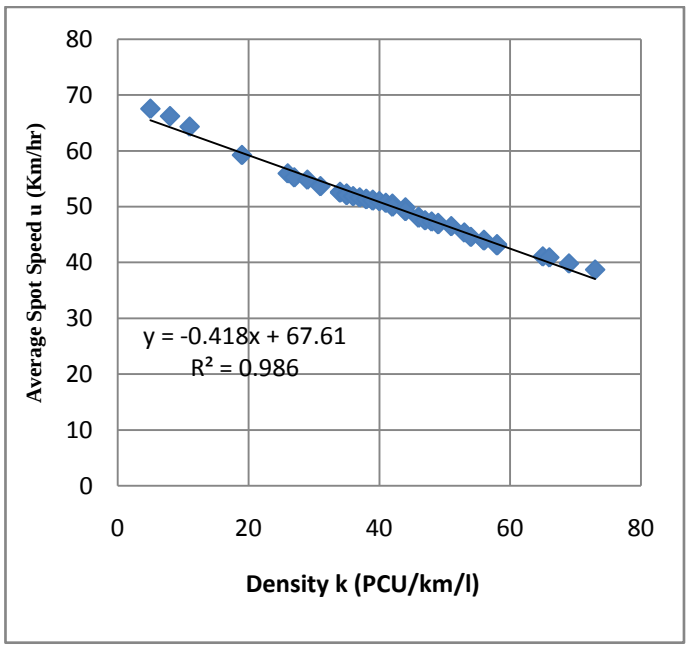

Fig. 3 Variation Average Spot Speed with Density.

CONCLUSIONS

The Level of service varies with the traffic composition as well as with traffic volume. Based on the analysis done for different highway's and comparative studies thereof the following conclusions have been drawn

- The results obtained using HCS-2000 clearly reflects that the deterioration in LOS is due to the increase in traffic volume and decrease in avg. spot speed.
- The traffic flow data collected at the mid-block sections of four lane highways are analysed to determine the LOS under mixed traffic condition. The present study demonstrates the effect of volume and avg. spot speed on LOS.
- For MSH-248 table 2 indicates that most of the vehicles perceives LOS D during morning Peak hour however during morning off peak hours both LOS C and LOS D are observed
- For MSH-255 the table 4 reflects that LOS D and LOS E are observed during morning peak hour indicating considerable amount of loss to the freedom of manoeuvre, and is a consequence of increase in traffic volume and reduction in avg. spot speed. However for evening off peak hour LOS C is observed most frequently over a time.
- For MSH-260 the variation of LOS over a peak and off peak hour is negligible and LOS B and LOS C are predominant.
- The comparative analysis for above three highways signifies that the supply side (Lane Width) of the transportation system affects directly to the LOS of highways.
- The Level of service F is not observed at any of the mid block sections since the traffic data was collected at the mid-block sections of the highways rather than at the intersections.

However the scope of this paper is limited to the assessment of level of service for morning peak hours and off peak hours. Since the level of service is a function of temporal as well as spatial variation of traffic flow as well as traffic speed therefore it is necessary to assess the level of service over a period of time in order to mitigate the congestion (if any) and provide the long term or short term remedial measures for the mitigation of congestion.

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