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LEVEL OF SERVICE CONCEPT IN URBAN ROADS

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***Abstract*— India is a developing country and our traffic in urban streets seeing a boost which affects the minimum quality or the level of facility to be provided by the road. Services to be provided by the road to user require quantitative ways to describe operational conditions within a traffic stream. Level of service (L.O.S.) is a quality measure which describes the operational conditions within a traffic stream, generally in terms of service provided by the road to the user. Determination of L.O.S. in urban areas is very much different from the concept applied in rural areas or uninterrupted roads. This paper shows about the methodology that can be implemented while determining L.O.S. in urban areas or controlled roads.**

***Keywords*— Level of Service, Urban Areas, Peak Hour Volume, Travel Speed, Methodolgy.**

I. INTRODUCTION

The vigorous development of urban areas and the expansion of big cities with increasing number of residents causes a tough challenge for the developing nations. By the starting of 21st century, our world pulls off two noteworthy feats. First, our world population crosses over seven billion mark. Second, out of seven billion, the population that resides in urban areas is nearly half, and experts predicted that at the end of 2025 our world population residing in urban areas will reach upto 60%. As for the magnitude, in 1901, in Indian urban areas number of people residing there are nearly 25 million which constitutes about 10.84 percent at that time of the total population. Since then the population of urban areas has increased to 28 percent of the total population in the next hundred years that is nearly 285 million. Urban areas in India includes broad range of big cities, developed cities and towns, all of these cities or town are not blessed enough in terms of transportation connectivity that are intra and intercity facilities. Transport in India, in this perspective has always suffered neglection, ignorance and confusion all these at the same time. Ministry of Road Transport & Highways (MoRTH), Government of India and Compound Annual Growth Rate (CAGR) provides the statistics which shows the population of motor vehicle in India had grown at a vigorous rate of nearly 10.5 percent annually during the period 2002 to 2012. Between the various categories of vehicles, the highest CAGR was recorded by cars, taxis and jeeps (11%) during the period 2002 to 2012 followed by two-wheelers (10.7%) which show increase in vehicles in urban areas. The growth rate of vehicles is not a bigger problem, but the main problem is that the growth is confined to some cities only, means maximum growth is only in few cities, particularly in cities having population in millions. MoRTH further shows the statistics that the metropolitan cities which constitutes about 11 percent of the total population contributes to 32 percent vehicles of the total vehicles. Something more shocking, the rate of growth of amount of traffic in six megacities is equivalent to four times faster than the rate of population increase of those cities. There were about one and half million new cars sold in India in 2007, an amount which exceeds the number sold in 2003 by more than twice, something frightening Indian transport system.

II. LEVEL OF SERVICE

The term "Level of Service" (L.O.S.) has been introduced by the Highway Capacity Manual (HCM) which represents the level of facility an user can derive from a road under various operating characteristics and traffic volumes. When a road is carrying traffic in equal volume to its capacity, or say volume to capacity ratio near to one, under ideal traffic and roadway conditions, the operating conditions become poor. Dropping of speed and the frequency of delays or stops mount up. The service which is offered by a roadway to the users' can differ under different traffic volumes. The term level of service is defined as a qualitative measure which describes the operational conditions within traffic stream, and their observation by motorists and/or travellers. The following are the factors which might be considered in evaluating the L.O.S.:

- Traffic interruptions or restrictions, with due consideration to the number of stops per kilometre, changing of speed and delays involved are the requirement to maintain the speed in the traffic stream.
- Speed and travel time, including the operating speed and overall travel time consumed in travelling over a section of roadway.
- Driving comfort and convenience reflecting the roadway and traffic conditions in so-far as they affect driving comfort and convenience of the driver.
- Freedom to maneuver to maintain the desired operating speeds.

HCM describes six L.O.S. based on different operating conditions. Six level of service described in HCM are from L.O.S. 'A' to L.O.S. 'F', road with L.O.S 'A' signifies the best operating conditions among all level of services and road having L.O.S. 'F' is the worst of all defined L.O.S.

A. LEVEL OF SERVICE IN URBAN AREAS

Level of service in urban area or controlled sections is totally different as that in rural areas or uncontrolled areas. The L.O.S. for urban and suburban arterials can be related to the flow conditions, average overall travel speed, load-factor at intersections, peak-hour factor, and service volume capacity ratio. The term peak hour factor is shown as the ratio of the peak hour volume to the rate flow which is maximum during a given time period within the peak hour (say 5 minutes, 10 minutes or 15 minutes). Urban street L.O.S. is majorly based on average travel speed of the vehicle for the segment under consideration.

Highway Capacity Manual (HCM, 2000) defined L.O.S. as "a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience.". The characteristics of different levels of service for urban and suburban arterials are summarised below in table I.

TABLE I
LEVEL OF SERVICE FOR URBAN AREAS

Level of service	Operating Characteristics
A	The average overall travel speeds is 50 K.P.H. or more relatively free flowing, with service volume capacity ratio of 0.60 or less. Load factor at intersections about 0.0. Peak hour factor at 0.70 or less.
B	Stable flow, Average overall travel speed drops down to 40 K.P.H. or more. Slight delay is common. Service volume/capacity ratio is 0.70 or less. Load factor about 0.11 or less, and peak hour factor 0.80 or less.
C	Stable flow, with acceptable delays. Average overall travel speed drops down to 30 K.P.H. or more. Service volume/capacity ratio is 0.80 or less. Load factor about 0.3 or less, and peak hour factor is 0.85 or less.
D	Approaching unstable flow, with tolerable delay. Average overall speed drops down to 25 K.P.H. Service volume/capacity ratio about 0.90 or less. Load factor 0.7 or less and peak hour factor 0.90 or less.
E	Unstable flow with congestion and intolerable delay. Average overall travel speed about 25 K.P.H. Service volumes are at capacity, or near about. Load factor at intersection 1.0 or less, and peak hour factor 0.95 or less.
F	Forced flow, with jammed conditions. Average overall travel speed below 15 K.P.H. Demand volume/capacity ratios may well exceed 1.0. Intersections overloaded.

Some factors influence level of service for the urban streets like number of signals a segment have per kilometre and control delay at intersections. Some other influencing factors such as poor progression, increasing traffic flow, and inappropriate signal timing can reduce the L.O.S. significantly. Urban streets having more than one signal per kilometre means streets with medium to high signal densities are more vulnerable to the above factors, and may lead to observation of poor L.O.S. even before notable problems occur. On the other hand, an individual signalized intersection might operate at lower levels but urban street segments longer in length comprises of heavily loaded intersections may provide reasonably a good L.O.S. The term through vehicle refers to all vehicles passing directly through a street segment and not turning.

III. METHODOLGY FOR DEFINING L.O.S IN URBAN AREAS

Level of service measure requires following steps to be conducted on the segment of road considered for defining L.O.S.:

(i) Defining study area.
(ii) Determining peak hour volume and peak hour factor.
(iii) Determining free flow speed.
(iv) Classify urban street type and class.
(v) Determining running time, delay time and hence to find the average travel speed during peak hours and non-peak hours using floating car method.
(vi) Analysis of data to determine L.O.S.

A. DEFINING STUDY AREA

The first step that is required for defining L.O.S. is defining study area where L.O.S has to be identified. Segment or road on which L.O.S. is to be identified is chosen such that minimum length of the segment is 3 kilometres. Segment chosen should be divided into small stretches for calculating running and delay time at the end of each stretch.

B. DETERMINING PEAK HOUR VOLUME AND PEAK HOUR FACTOR

For the determination of peak hour volume, traffic volume count is to be done along the chosen segments. Method used for the determination of traffic count can be automatic or manual count. In manual count method people are employed for the traffic count which is noted down. Traffic count shall be done mainly during peak hours to ascertain the peak hour factor. The peak hour factor is defined as the ratio of the volume occurring during the peak hour to the maximum rate flow during a given time period within the peak hour. Time period of 15 minutes is generally taken for determining flow and maximum value equivalent to hourly rate is used for determining peak hour factor.

C. DETERMINING FREE FLOW SPEED

Free flow speed (FFS) is the average speed of the traffic flow when volumes are adequately low that drivers are not influenced by the presence of other vehicles and when intersection traffic control (i.e. signal or sign) is not present or is satisfactorily distant so as to have no effect on speed choice. Free flow speed is determined in the mid section of the roadway during non-peak hours or we can say that when there are no restructions causing vehicle to reduce its speed. In determining FFS, two lines are marked in the mid-block of the road separated by a distance say 100m. During low density, when a vehicle enters the first marked line, the stopwatch is started and remained on till the vehicle leaves the second marked line, after that stopwatch is stopped and time is noted down on the diary. Hence, FFS can be determined by simply using a stopwatch by noting the time taken by the vehicle to travel the marked distance. The free-flow speed is used to determine the urban street class and to estimate the segment running time. This measurement should be made under low flow conditions (less than 200veh/hr/lane).

D. CLASSIFY URBAN STREET TYPE AND CLASS

Urban street type classification will be based on the data acquired through surveys of the roads and from the functional parameters of road or segment. Functional parameters will give an idea about the street type being principal arterial or minor arterial as shown in table II.

TABLE II
URBAN STREET BASED ON FUNCTIONAL PARAMETERS

	Functional Category	
Criterion	**Principal Arterial**	**Minor Arterial**
Mobility function	Very important	Important
Access function	Very minor	Substantial
Points connected	Freeways, important activity centers, major traffic generators	Principal arterials
Predominant trips served	Relatively long trips between major points and through- trips entering, leaving, and passing through the city.	Trips of moderate length within relatively small geographical areas.

Beside functional parameters urban street is classification is also done on the basis of design category. Road survey is done to classify the urban street on the basis of design category. Road survey constitutes of posted speed limit, driveway/access-point density, signal density, and other design features as shown in table III. For the classification of urban street type through design parameters a brief survey of the roads considered will give an idea about the street being high-speed, sub-urban, intermediate or urban type. From table III urban street types will be defined along with the data obtained through road surveys.

TABLE III
DESIGN PARAMETERS FOR CLASSIFYING URBAN STREET TYPE

Criterion	Design Category			
	High Speed	**Sub urban**	**Intermediate**	**Urban**
Arterial type	Multilane divided; undivided or two-lane with shoulders	Multilane divided; undivided or two-lane with Shoulders	Multilane divided or undivided; one- way, two- lane	Undivided one-way, two- way two or more lanes
Driveway/Access Density	Very low density	Low density	Moderate density	High density
Parking	No	No	Some	Significant
Separate Left Turns	Yes	Yes	Usually	Some
Signals/ Km	0.3– 1.2	0.6– 3.0	2– 6	4– 8
Speed limit	75– 90 km/h	65– 75 km/h	50– 65 km/h	40– 55 km/h
Pedestrian activity	Very little	Little	Some	Usually
Roadside Development	Low density	Low to medium density	Medium to moderate density	High density

After defining urban street type with functional and design parameters, urban street class is to be defined. The classes given in HCM are designated by number (i.e., I, II, III, and IV) and reflect unique combinations of street function and design, as shown in table IV.

TABLE IV
URBAN STREET CLASS BASED ON FUNCTIONAL AND DESIGN PARAMETERS

Design Category	Functional Category	
	Principal Arterial	**Minor Arterial**
High-Speed	I	N/A
Suburban	II	II
Intermediate	II	III or IV
Urban	III or IV	IV

E. DETERMINING RUNNING TIME, DELAY TIME AVERAGE TRAVEL SPEED

Level of service of urban or controlled sections is primarily defined by the travel speed along segments, and is mainly calculated from the data obtained by field. Out of various methods, floating car method is the most commonly used method to obtain speed data of the section. In this method minimum of three people are required, a driver drives the vehicle and two passengers record the elapsed time information i.e. running time and delay time, at predefined check points. The recording of elapsed time can be done by audio recorder, pen and paper or with a small data recording device. The floating car method is quite advantageous as it requires very low experienced technician and equipments with low cost. Floating car method is to be done during both peak and non-peak hours to see the variations in running time, delay time and average travel speed.

F. ANALYSIS OF DATA TO DETERMINE L.O.S.

Urban street L.O.S. criteria based on urban street class and average travel speed. In case the demand volume at any point exceeds the capacity on the segment, then the average travel speed calculated might not be a good measure of the L.O.S. In the above steps determination of urban street type and average travel speed is described and with the help of table V given below will classify the L.O.S. of the urban street chosen.

TABLE V
URBAN STREET L.O.S. BY CLASS

Urban Street Class	**I**	**II**	**III**	**IV**
L.O.S.	**Average Travel Speed (km/h)**			
A	>72	>59	>50	>41
B	>56-72	>46-59	>39-50	>32-41
C	>40-56	>33-46	>28-39	>23-32
D	>32-40	>26-33	>22-28	>18-23
E	>26-32	>21-26	>17-22	>14-18
F	≤26	≤21	≤17	≤14

IV. CONCLUSIONS

L.O.S. determination in urban areas or streets is dissimilar to that of rural areas. In rural areas L.O.S. is based on density, flow, space headway etc. but in case of urban streets L.O.S. determination is totally based on average travel speed, delay time, running time and urban street type and class.

For urban streets a minimum of L.O.S. C is required as mentioned in HCM. This means for different urban street classes average travel speed vary from 40-56 kmph for urban street class I to 23-32 kmph for urban street type IV.

Traffic count should be done in a time interval of 15 minutes. Maximum 15 minutes traffic is converted into hourly duration. And then peak hour factor determined should be 0.85 or less for the level of service C.

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