VEHICULAR SPEED PATTERN ANALYSIS ON ACCESS CONTROLLED URBAN ROADWAY IN SURAT CITY

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Abstract— Driving cycle is depicted by a series of data points representing the speed of a vehicle versus time. The quality of a driving cycle is directly associated with the accuracy of any air quality analysis. The data collection of driving cycle comprises of selection of instrumentation, data collection technique, test route selection and days of collection technique. Performance Box is one of the instruments use for data collection. Data has been collected on Sardar Bridge at Adajan, Surat. Data analysis is done by statistical approach. One way ANOVA is used to compare effect of different mode of vehicles on driving cycle parameters.

Index Terms— ANOVA, Driving Cycle

I. INTRODUCTION

Driving cycles are used to assess the performance of vehicles in various ways and, as the most common example, to assess polluting emissions and fuel consumption in vehicle. Most of the macroscopic emission factors modeling systems have used the concept of driving cycles for the collection of their essential data. On the other hand, the microscopic emission models use driving cycles to transform instantaneous emissions into average emission factors.The driving cycle is a representative plot of driving behavior of a given city or a region and is characterized by speed and acceleration. Driving cycle data has been collected on working day (Monday), Saturday and Sunday. Data is collected by different modes of vehicles like bike, auto rickshaw and car. The effect of modes of vehicle on speed profile is analyzed with statistical approach.

Data analysis was done by SPSS software to find out driving cycle parameter (acceleration, deceleration, cruise speed and average speed)When compare means of more than two groups of variables, one way ANOVA can be used. ANOVA is used to find significant relation between various variables. One way ANOVA is used to find out effect of bike, car and auto rickshaw on vehicle speed.

II. CASE STUDY

Surat is Gujarat's second largest city with a population of 2.1 million at the 2001 census and 4.6 million at the 2011 census. Surat Municipal Corporation arises to improve road infrastructure of the city. Since last two decades most of the new development, including the most desirable location for the city's middle and upper class, is

the Adajan area. Sardar bridge of study area is the link between Adajan area and athwalines area. Fig. 1 shows morning pick hour traffic congestion at conflict point. Maximum vehicle speed fluctuation is observed at merging point during morning peak hour.

Fig. 1 Conflict point at Sardar Bridge, Surat

Performance Box is one of the instruments used for data collection at selected area. Performance Box is very easy to measure acceleration times, braking distances, quarter mile times and many more. There are a number of configurable screens that show specific test results such as 0-60, 0-100, 0-100-0, ½ mile and ¼ mile etc.

Performance Box is a very powerful tool for use in many different kinds of vehicle testing. Vehicle modification can be readily assessed and given specific improvement parameters – the perfect tool for any tuning enthusiast.

Performance Box is a self-contained GPS data logger and Performance Meter. A 10 Hz fully calibrated GPS engine is used to provide accuracy and precision and the data can be stored on a removable SD flash card. Real time results are displayed on the back-lit LCD display and a USB connection allows data to be downloaded to a laptop for further in-depth analysis.

III. DATA COLLECTION

Corridor selection basically depends on the type of study. The objective of the study is to observe the variation in driving parameters in different driving conditions and different modes of urban transport.

Data collection has been done at Sardar bridge, Adajan at merging conflict point. Traffic congestion is high at morning peak hour (9: 30 am to 10:30 am) from bhulka bhavan approach to Athwagate. Traffic from Gujrat Gas circle and Bhulka Bhavan merges at brige. Driving cycle data was collected with reference to the merging point of bridge, Fig. 3 indicates an uncontrolled intersection at a stretch of 200 m. Fig 2 shows data collection is done in car by V Box.

Fig. 2 Data collection by V- Box

Fig. 3 Section of Data collection

Table I Total no. of trips

Mode	Monday	Saturday	Sunday	Total
Bike	**3**	**3**	**3**	**9**
Car	**3**	**3**	**3**	**9**
Auto rickshaw	**3**	**3**	**3**	**9**

Base data contains 9 complete trips made on the bikes, cars and auto rickshaws. Total 9 trips are collected from the each day (Monday, Saturday and Sunday) as shown in Table I.

Driving cycle pattern

Driving cycle pattern of bike, car and auto rickshaw is collected for working day, Saturday and Sundays. Vehicle drives three times to get three driving cycle for each mode. Fig. 4, 5 and 6 show driving cycle pattern of each vehicle on Monday. Similarly it is collected for Saturday and Sunday.

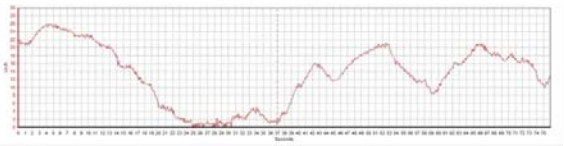

Fig. 4 Driving cycle pattern of Bike (Monday)

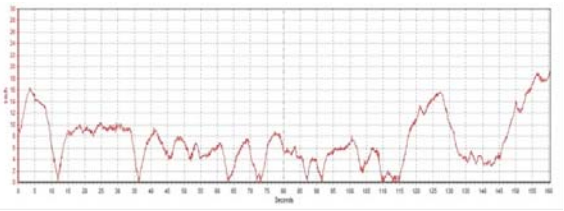

Fig. 5 Driving cycle pattern of Car (Monday)

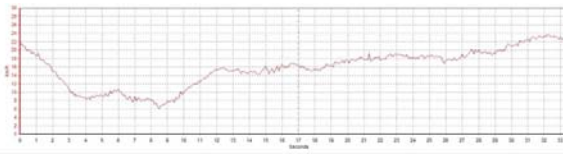

Fig. 6 Driving cycle pattern of Auto Rickshaw (Monday)

IV. DATA ANALYSIS

Speed and acceleration can be calculated from the V-box data, the parameters based on Speed and acceleration values which will set one of the important criteria for analysis. Total five driving parameters with their criteria are calculated according to following condition

1. Percentage acceleration in the base data (acceleration > 0.5 km/h /s)
2. Percentage deceleration in the base data (acceleration < -0.5 km/h /s)
3. Percentage cruise in the base data (speed > 5km/hr and acceleration < |0.5km/h/s|)
4. Percentage idle time (acceleration < |0.5 km/h/s| and speed < 5 km/h)
5. Average Speed

Data analysis has been done for driving cycle parameters by calculating percentage of acceleration, deceleration, cruise and idle phase for all modes of vehicle for different days. Statistically, all parameters are checked for standard deviation, mean and variance.

One way ANOVA is used to compare means of different population group. In present study one way ANOVA is used to compare driving cycle parameters with vehicle modes.

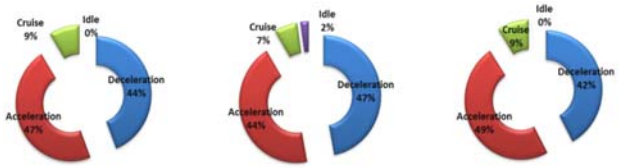

Fig. 7 Driving cycle parameters for Bike (Monday)

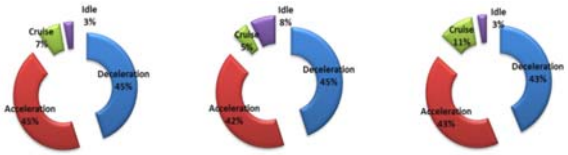

Fig. 8 Driving cycle parameters for car (Monday)

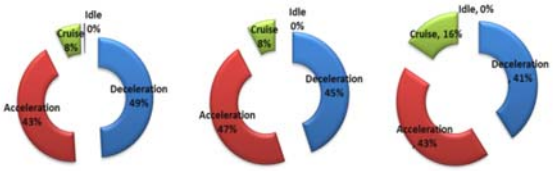

Fig. 9 Driving cycle parameter for Auto rickshaw (Monday)

Fig. 7,8 and 9 show the average value of percentage of driving parameters for working day for bike with 44 % deceleration , 47 % acceleration ,8 % cruise and 1 % idle , for car 44 % deceleration , 43% acceleration , 8 % cruise and 5 % idle and for auto rickshaw 45% deceleration , 45 % acceleration , 10% cruise with no idle period.

The average speed of all three cycles for bike is 14 kmph, for car 8 kmph and auto rickshaw 16 kmph as shown in Fig. 10. The average speed of car is less compared to bike and auto rickshaw.

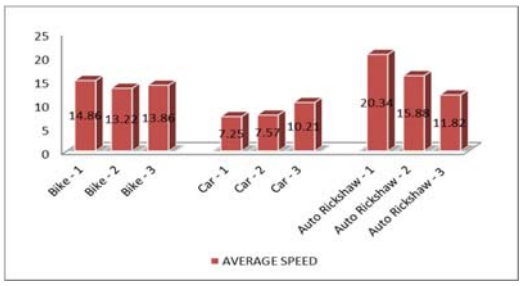

Fig. 10 Average speed of vehicle (Monday)

The average speed of all three cycles for bike is 20 kmph, for car 11 kmph and auto rickshaw 12 kmph as shown in Fig. 11. The average speed of car and auto rickshaw is less compared to bike.

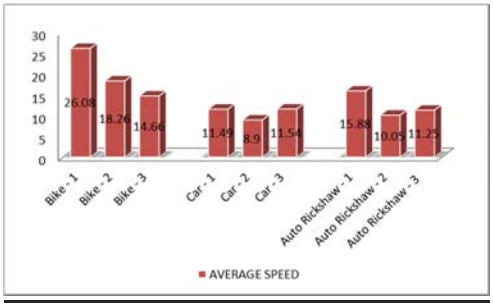

Fig. 11 Average speed of vehicle (Saturday)

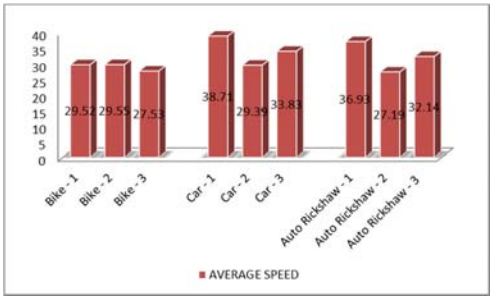

Fig. 12 Average speed of vehicles (Sunday)

The average speed of all three cycles for bike is 29 kmph, for car 34 kmph and auto rickshaw 32 kmph as shown in Fig.12.

One way ANOVA (ANalysis Of VAriance)

The ANOVA test is done with following assumptions

1. Population normality: data is numerical representing samples from normality distributed populations.
2. Homogeneity of variance : the variances of the groups are similar
3. The groups should be independent

ANOVA tests the null hypothesis that the means of the all groups being compared are equal, and produces a statistic called F. if the means of all the groups tested by ANOVA are equal.

Homogeneity of variance is one of the assumptions of ANOVA test, so not necessary to conduct it. Levene's test shows that homogeneity of variance is not significant ($p > 0.05$), one can be confident that population variances for each group are approximately.

ANOVA table shows F test values along the degree of freedom and significance. If $p > 5$ % null hypothesis is accepted.

Table II Homogeneity of variance (Monday)

Levene's Statistic	df1	df2	Sig.
34.551	2	2624	.000

Table III ANOVA test result (Monday)

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	42.585	2	21.292	.966	.381
Within Groups	57821.25	2624	22.036		
Total	57863.83	2626			

Table IV Homogeneity of variance (Saturday)

Levene's Statistic	df1	df2	Sig.
53.019	2	1472	.000

Table V ANOVA test result (Saturday)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	26.025	2	13.01	.853	.426
Within Groups	22455.15	1472	15.25		
Total	22481.18	1474			

Table VI Homogeneity of variance (Sunday)

Levene's Statistic	df1	df2	Sig.
.064	2	1016	.938

Table VII ANOVA test result (Sunday)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.798	2	1.899	.198	.820
Within Groups	9748.00	1016	9.594		
Total	9751.80	1018			

One way ANOVA is conducted for all driving cycles of Monday, Saturday and Sunday. Means of cycle 1- Bike, cycle 1 -Car and cycle 1- Auto rickshaw are compared within and between groups. Similarly for cycle 2 and cycle 3 of all days are compared. Null hypothesis is assumed that there is no significant difference of vehicle mode on driving parameter.

First assumption homogeneity of variance was performed, which has $p < 0.05$ for all groups of Monday, Saturday and Sunday. It indicates that null hypothesis is rejected and follow F test (ANOVA), which is shown in Table II, IV and VI. After Leven's F test, results are generated by one way ANOVA. Tables III, V and VI show the significance value of null hypothesis, which is more than 0.05, so null hypothesis is accepted. It interprets that there is no effect of vehicle type on driving parameter like acceleration, deceleration and cruise speed.

Distance – Time Relationship

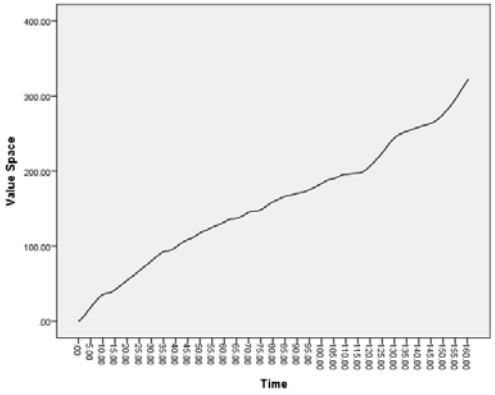

Fig. 13 Space – Time Trajectory (Monday)

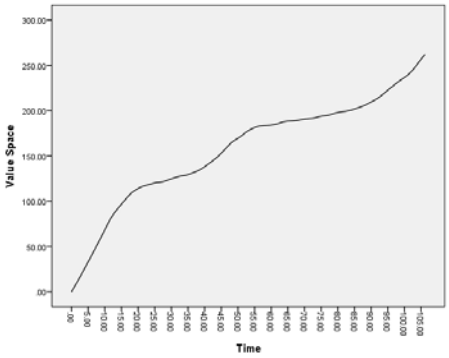

Fig. 14 Space – Time Trajectory (Saturday)

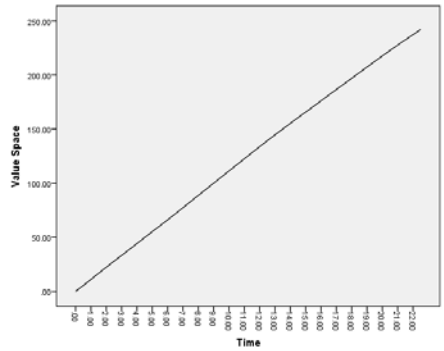

Fig. 15 Space – Time Trajectory (Sunday)

Speed Time trajectory is shown in Fig. 13, 14 and 15 for Monday, Saturday and Sunday respectively. From the space – time relation it is observed that the speed is constant on Sunday due to less traffic volume, whereas during week days speed fluctuation is observed significantly.

V. CONCLUSION

Driving cycle parameters have been calculated for three modes of vehicle for three days of week. The real world data was collected by V box and analysis was done. Analysis is based on five important parameter of speed – time profile; percentage acceleration, deceleration and cruise, idle and average speed.

Driving cycle parameters for working day and Saturday have percentage acceleration and deceleration approximate 45%, cruise 10% with idle time 4-5 % for all three modes, whereas on Sunday percentage acceleration and deceleration is approximate 40 %, cruise 15% with idle time 0 % for all three modes during morning peak hour. Traffic volume on working day and Saturday is higher than the Sunday, so cruise period is less on working day and Saturday with idle period. Sunday all cycles have no idle period

because of less traffic volume. The average speed of vehicles on Sunday is higher than Saturday and working day.

One way ANOVA is used for Statistical analysis. Analysis is done for driving cycle parameter with respect to modes of vehicle. By performing the test the p value is greater than more generally of the driving conditions on the emission. All the pollutants are sensitive to acceleration parameters (frequency of accelerations and strong accelerations, average acceleration, time spent at high acceleration)

5%, so null hypothesis is accepted for all cases and It is concluded that there is no effect of vehicle type on driving parameter.

The variations induced by the driving conditions can be more significant than the variation induced between the vehicles. This highlights well the importance of the driving cycle and

REFERENCES

[1] Andr, M., Rapone, M., Joumard, R., & Inrets-lte, R. (2006). Analysis of the cars pollutant emissions as regards driving cycles and kinematic parameters, Report INRETS – LTE 0607, March 2006

[2] Ricardo G. Sigua (1997), "Development of driving cycle for metro manila", Journal of Eastern Asia Society for Transportation Studies, vol. 2, No. 6, Autumn, 1997

[3] Dresser, C. (2011). "Project-Level Modeling in MOVES, Office of Transportation and air quality, U.S Environmental protection agency, 1–12.

[4] Fellendorf, M., & Vortisch, P. (2010). "Microscopic Traffic Flow Simulator VISSIM" International series in Operations research & Management Science 145,(pp. 63–94).

[5] Fotouhi, A. (2013). "Tehran driving cycle development using the k-means clustering method", Sharif University of Technology Scientia Iranica, 20(2), 286–293.

[6] Jie Lin, Debbie A. Niemeier, "Estimating Regional Air Quality Vehicle Emission Inventories: Constructing Robust Driving Cycles", Transportation Science INFORMS, Vol. 37, No. 3, August 2003, pp. 330–346

[7] Karabasoglu, O., & Michalek, J. (2013). "Influence of driving patterns on life cycle cost and emissions of hybrid and plug-in electric vehicle powertrains". Journal of Energy Policy, 1–17.

[8] Lei Yu. Ziqianli Wang,and Qinyi Shi, " PEMS- based approach to developing and evaluating driving cycle for air quality assessment, centre of transportation training and research , Texas southern university, April 2010

[9] Naghizadeh, M., Simulation, S., Cycle, D., & Economy, F. "Development of car drive cycle for simulation of emission and fuel economy", Proceeding 15th European simulation Symposium, SCS European Council/ SCS Europe BVBA, 2003 ISBN 3- 936150-28-1