PTV USER GROUP MEETING 2017

"TRAFFIC SIMULATION IN VISSIM FOR SIGNALIZED INTERSECTION OF VADODARA CITY"

Urban Mobility India (UMI) Conference – 2017

Boski P. Chauhan

Research Supervisors
Dr. G.J. Joshi (SVNIT, Surat)
Dr. Purnima Parida (CSIR CRRI, Delhi)

Department of Civil Engineering
Sardar Vallabhbhai National Institute of Technology Surat-7, Gujarat

Presentation Outline.........

1. Introduction
2. Objectives of the study
3. Literature Study
4. Methodology
5. Study area
6. VISSIM model for signalized intersection
7. Calibration of model
8. Results and Discussion

References

INTRODUCTION

- Vehicular population in urban areas has placed environmental stress through vehicular exhaust emissions
- Emission rates depend mainly on the characteristics of driving in different situations including speed, acceleration, deceleration, idling-stop and maximum speed.
- In order to fulfil efficient measures for controlling and adapting vehicles emissions, it is mandatory to develop an integrated microscopic model which replicates the actual situation.
- VISSIM (**V**erkehr **I**n **S**tädten – **SIM**ulationsmodell) is a traffic flow modeling program used to simulate various traffic scenarios. VISSIM is a microscopic, behaviour based simulation model.
- Present study highlights the speed - time characteristics of signalized intersection situated at Vadodara city of Gujarat, India, with traffic simulation model VISSIM.

Objectives of research

- The main objective of current study is to identify intersection influence zone.
- To analyse driving cycle (Speed – time profile) characteristics at intersection
- Three driving parameters; percentage acceleration, percentage deceleration and percentage idle time is calculated from driving cycle.
- To generate driving cycles from VISSIM model.

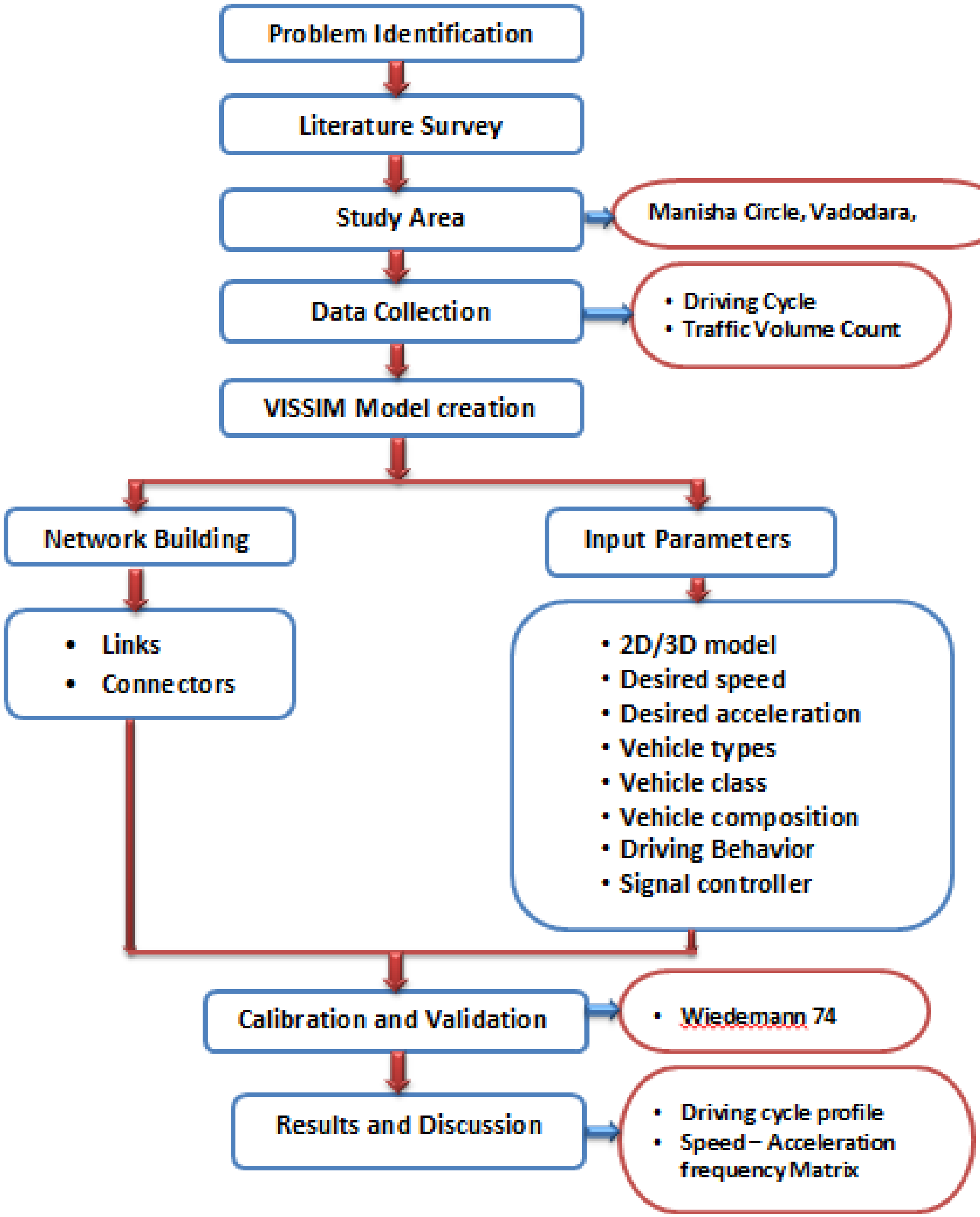
Literature Study

Sr. No.	Authors	Title	Description
1	Sanghpriya H. Kamble, Tom V. Mathew, G.K. Sharma (2009)	Development of real-world driving cycle: Case study of Pune, India.	Proposed methodology to develop the driving cycle using micro-trips extracted from real-world data with considering parameters of the time–space profile namely, percentage acceleration, deceleration, idle, cruise, and the average speed.
2	Ravi Sekhar, Pranoy Raj, Purnima Parida, S.Gangopadhyay (2013)	Estimation of Delay and Fuel Loss during Idling of Vehicles at Signalised Intersection in Ahmedabad	Estimated delay and fuel loss during idling vehicles at signalized intersections in Ahmedabad city. VISSIM micro simulation software was adopted to simulate the traffic movement on the study corridor.
3	H. Sebastian Buck, Nicolai Mallig and Peter Vortisch (2017)	Calibrating Vissim to Analyze Delay at Signalized Intersections	Built Vissim models for four signalized intersections and extracted information on headways, time to pass the intersection, and arrival distribution.

Literature Study

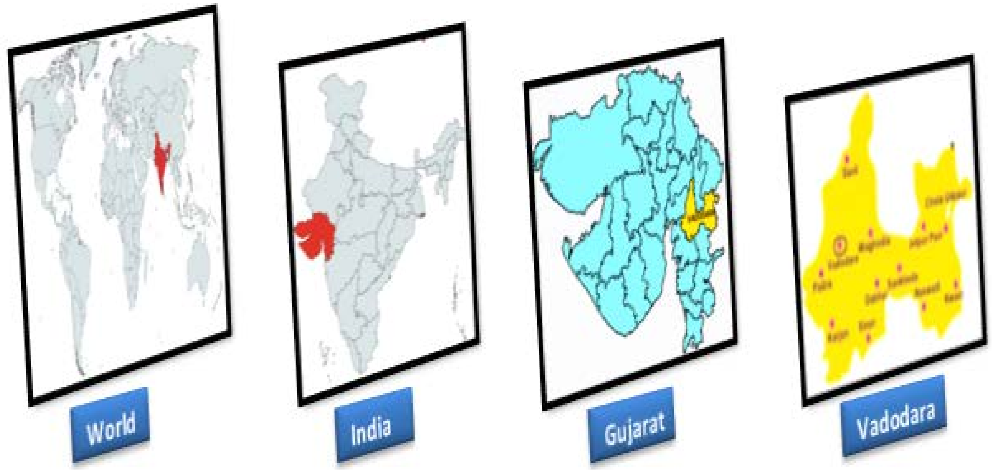
Sr. No.	Authors	Title	Description
4	John B. Partin, Tim O. Moore, Wakeel Idewu (2015)	Comparison of measured and modeled vehicle emissions for advance prediction of air quality and NO_x exposure level	Developed model in VISSIM to estimate emission for the parameters of average speed, total distance travelled and total stop delay for Indian River road, Chesapeake, Virginia.
5	Meng Li, Kanok Boriboonsomsin, Guoyuan Wu, Wei-Bin Zhang, and Matthew Barth (2009)	Traffic Energy and Emission Reductions at Signalized Intersections: A Study of the Benefits of Advanced Driver Information	Focused on providing information to the drivers with advanced signal status specifically for energy and emissions reduction. A generic method has been explained to analyze the effect of intersection influence on vehicle energy and emissions.
6	Hatem Abou-Senna, Essam Radwan, Kurt Westerlund, and C. David Cooper (2013)	Using a traffic simulation model (VISSIM) with an emissions model (MOVES) to predict emissions from vehicles on a limited-access Highway	Explained a model for limited-access urban highway in Orlando, FL, using a popular microscopic traffic simulation model, VISSIM, coupled with a U.S. EPA mobile source emissions model, MOVES2010a.

METHODOLOGY



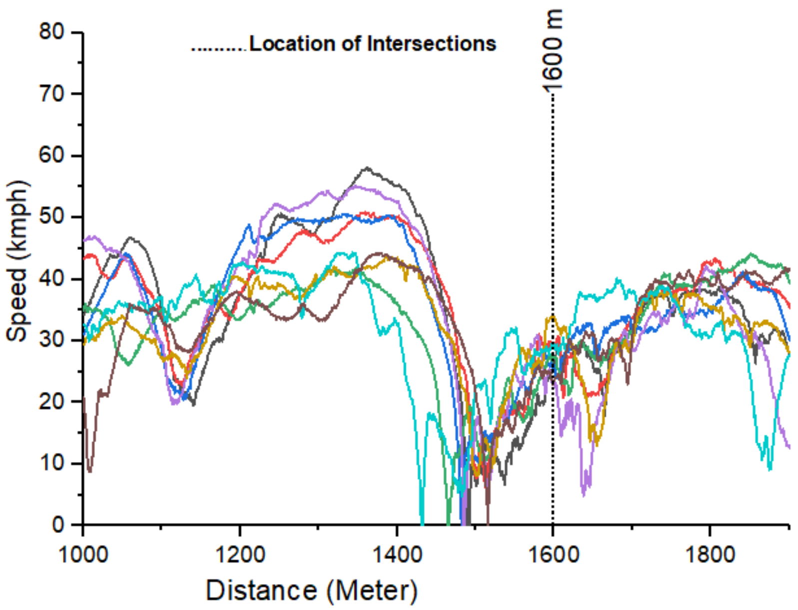
Study Area

Vadodara, also known as Baroda, is the third largest city in the Indian State of Gujarat. Manisha Circle is located on Old Padra road which faces hazards traffic problem almost every day. Driving cycle data has been collected by performance box in morning peak hour.

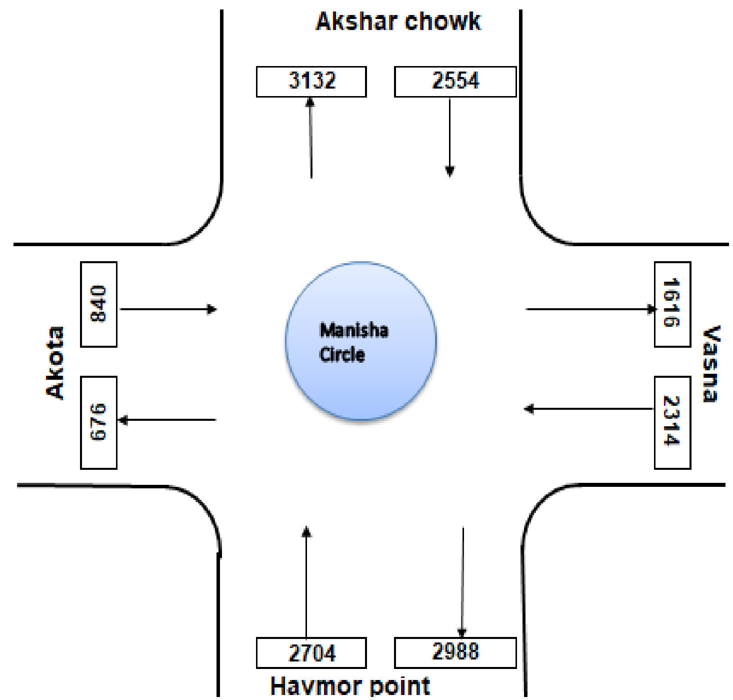


Manisha Circle

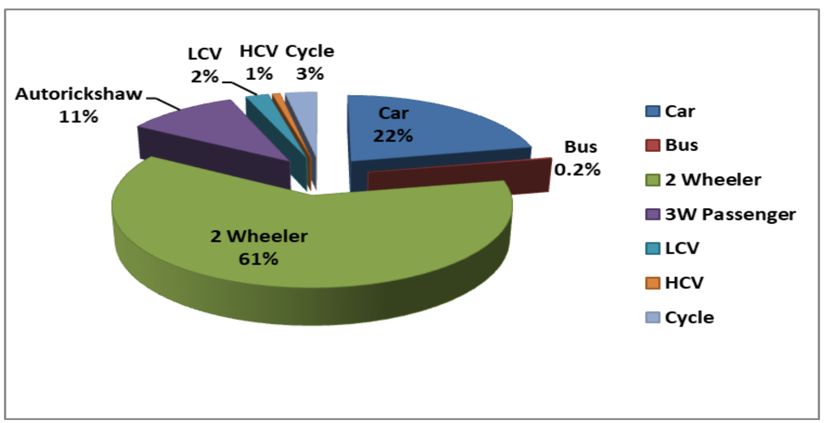
Performance box



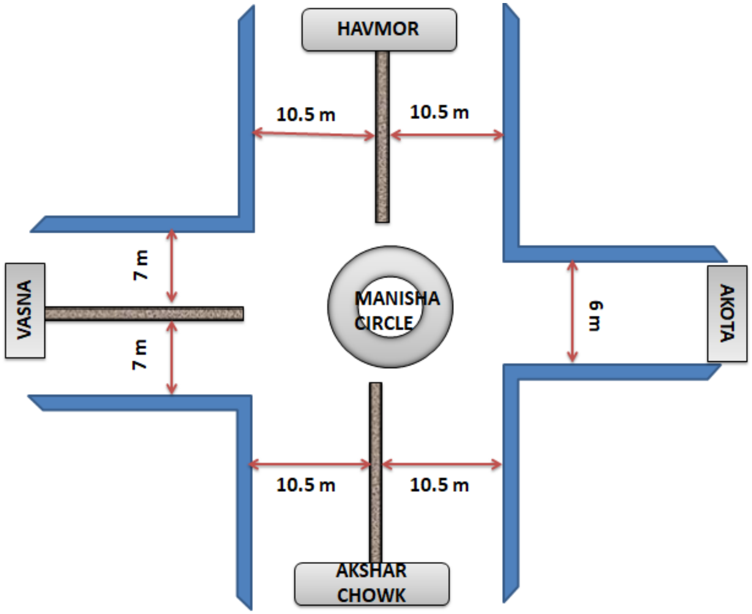
Driving cycle profile at Manisha circle

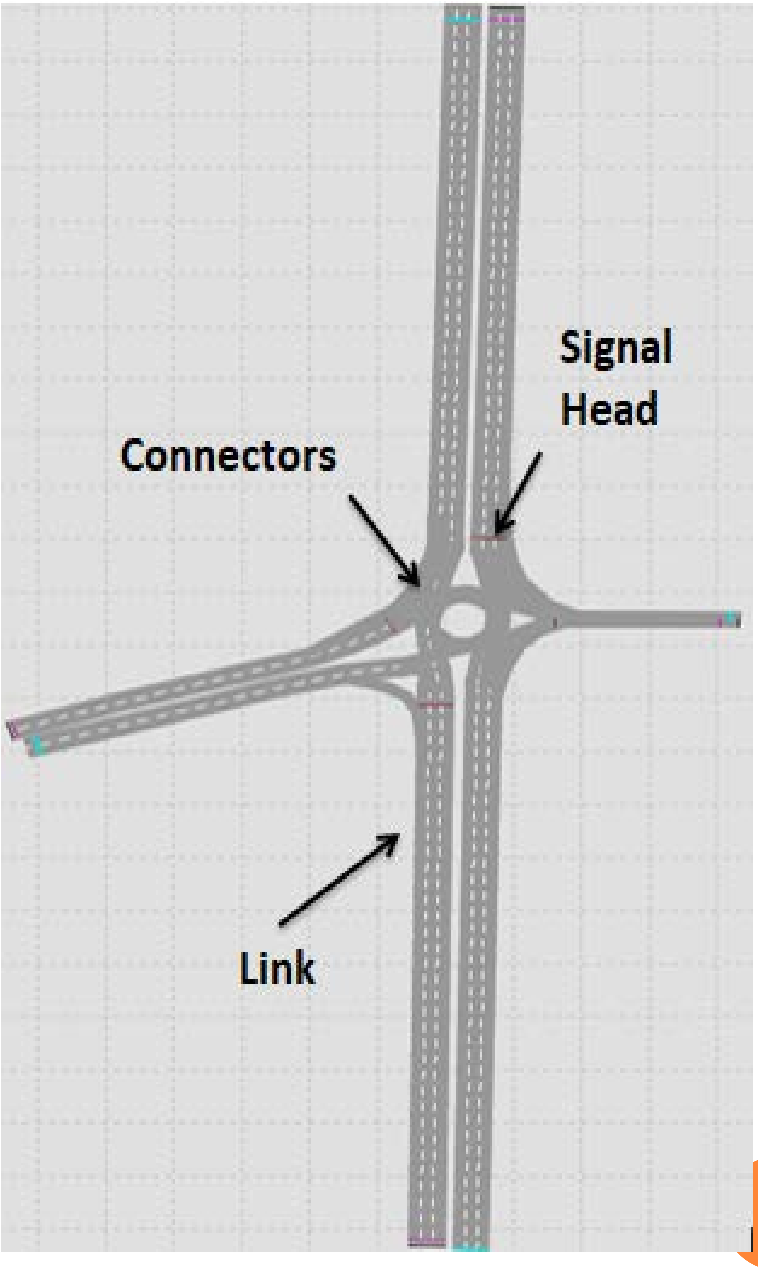


Traffic volume at Manisha circle



Vehicle composition at Manisha circle



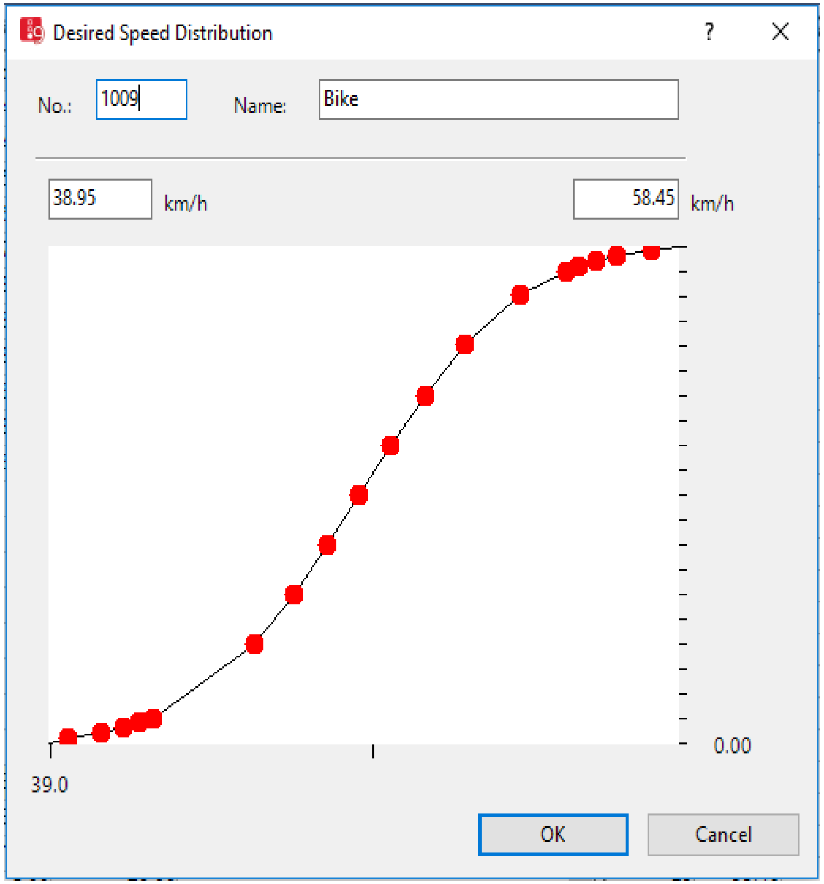


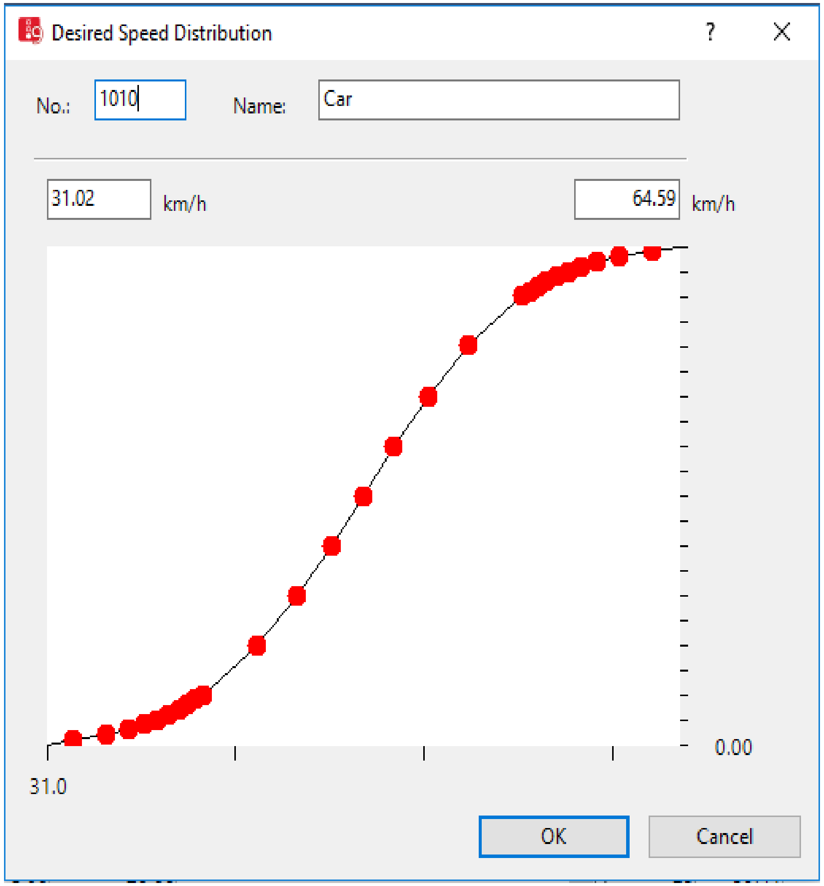
VISSIM network for Manisha Circle

VISSIM MODEL PARAMETERS

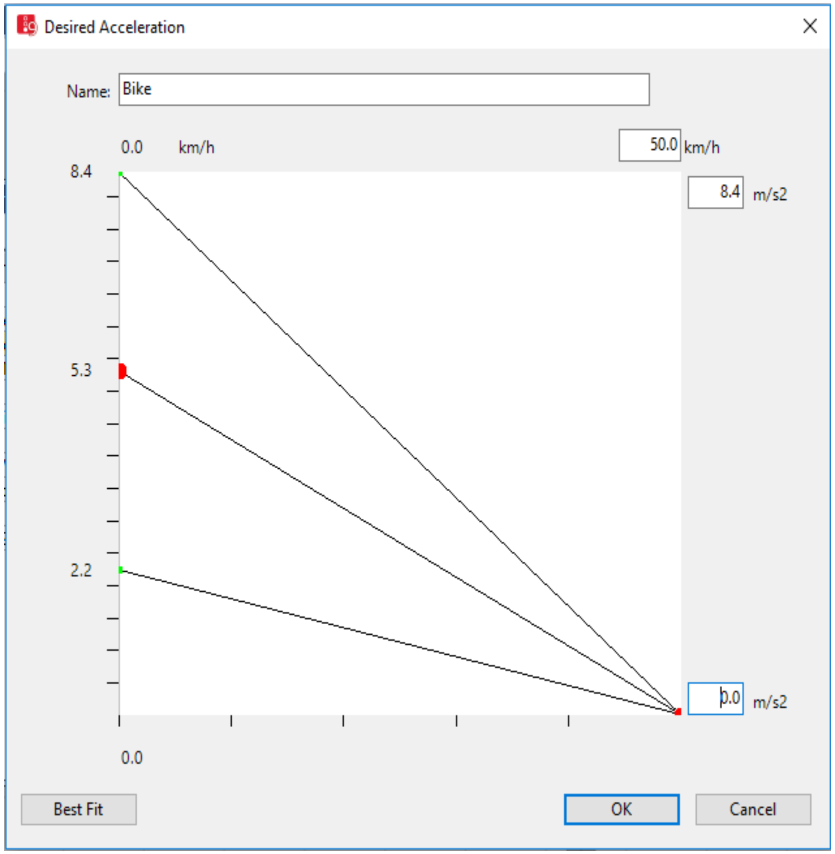
- **2D/3D model**
- **Desired acceleration**
- **Desired speed**
- **Vehicle types**
- **Vehicle class**
- **Vehicle composition**
- **Driving Behavior**
- **Signal controller**

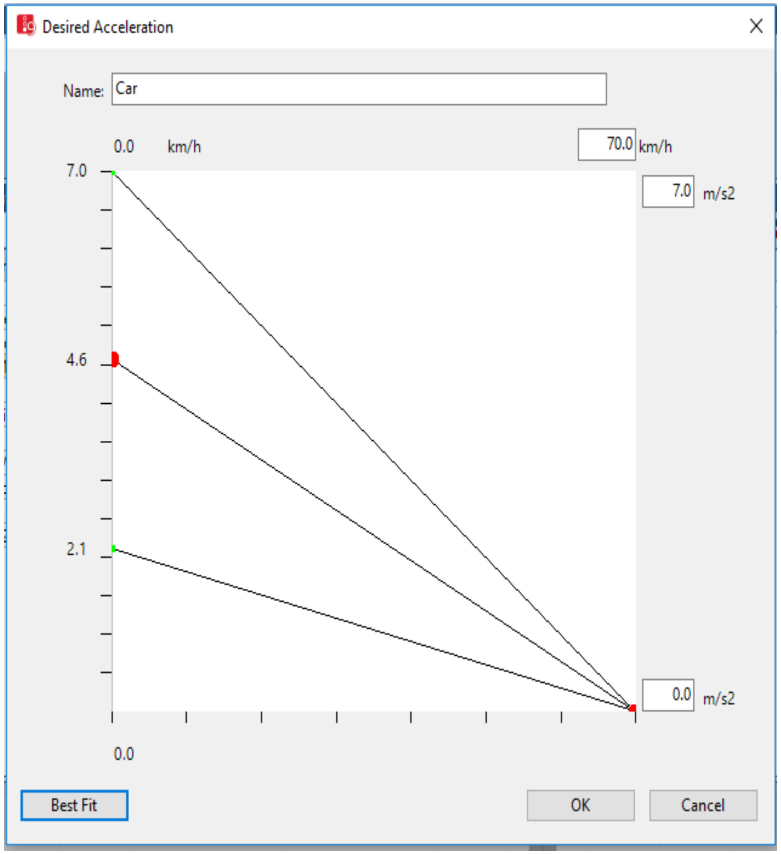
Desired speed distribution





Desired Acceleration Distribution





$X = \mu \pm Z\sigma$

Upper bound = $\mu + Z\sigma$ and

Lower bound = $\mu - Z\sigma$

$Z = 1.96$ (95% confidence interval)

Driving Behavior

- Operational calibration parameters in VISSIM control the driver behavior characteristics of individual vehicles in the simulation model.
- They play a large role in the capacity calibration of a model. The main categories of operational calibration parameters include car following behavior, necessary lane changing behavior and lateral distances.
- The basic premise of the car following Wiedemann model states that a vehicle is in one of four states of car following; free, approaching, following, or braking.
- This model accounts for psychological aspects as well as for physiological restrictions of drivers' perception so it is called psycho-physical car-following model.

WIEDEMANN 74 MODEL

- Minimum desired distance in model is calculated as:

$$d = ax + ((bx\_add + bx\_multi * z) * \sqrt{v})$$

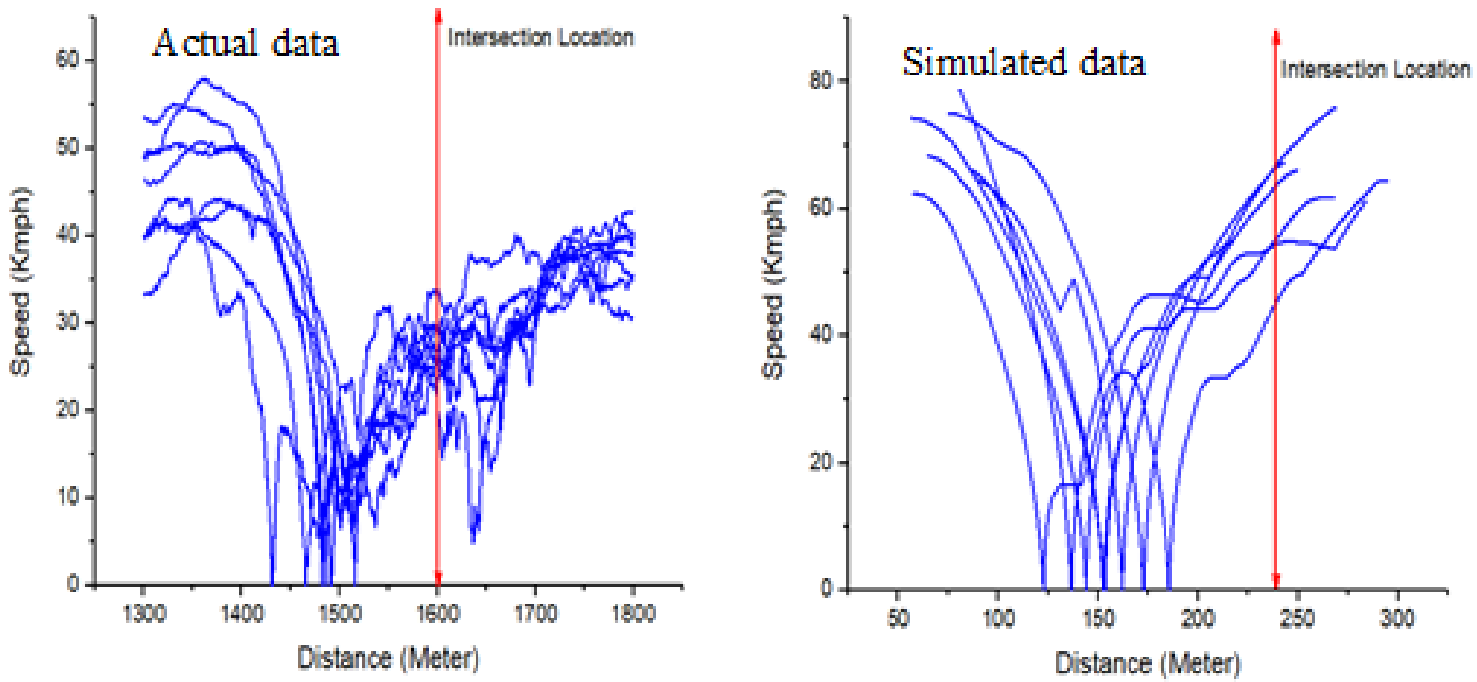
ax = average standstill distance
(Average desired distance between two cars (m))
bx_add = additive part of safety distance which allows to adjust time requirement values
bx_multi = multiplicative part of safety distance which allows to adjust time requirement values
v = speed of slower vehicle [m/s]
z = is a value of range [0,1], which is normally distributed around 0.5 with a standard deviation of 0.15

Calibrated parameter for Wiedemann 74

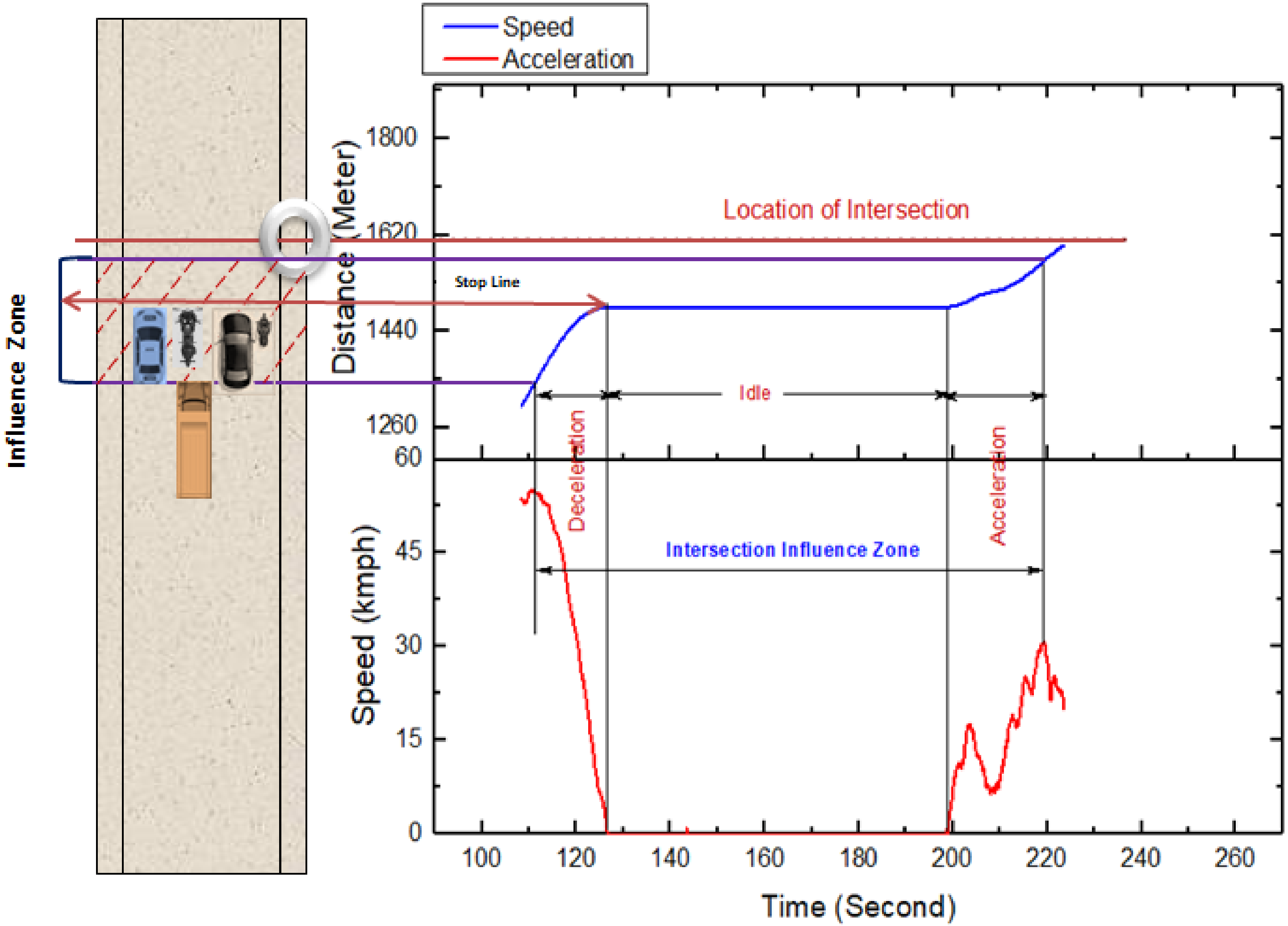
Sr No.	Vehicle Category	Parameters		
		ax	bx_add	bx_multi
1	Cycle	0.3	0.5	0.7
2	Bike	0.7	0.3	0.5
3	Car	0.5	0.3	1.5
4	Auto rickshaw	0.7	0.5	0.7
5	LCV	1.0	0.5	1.0
6	HGV	1.0	0.5	1.0
7	Bus	1.0	0.5	1.0

VISSIM model

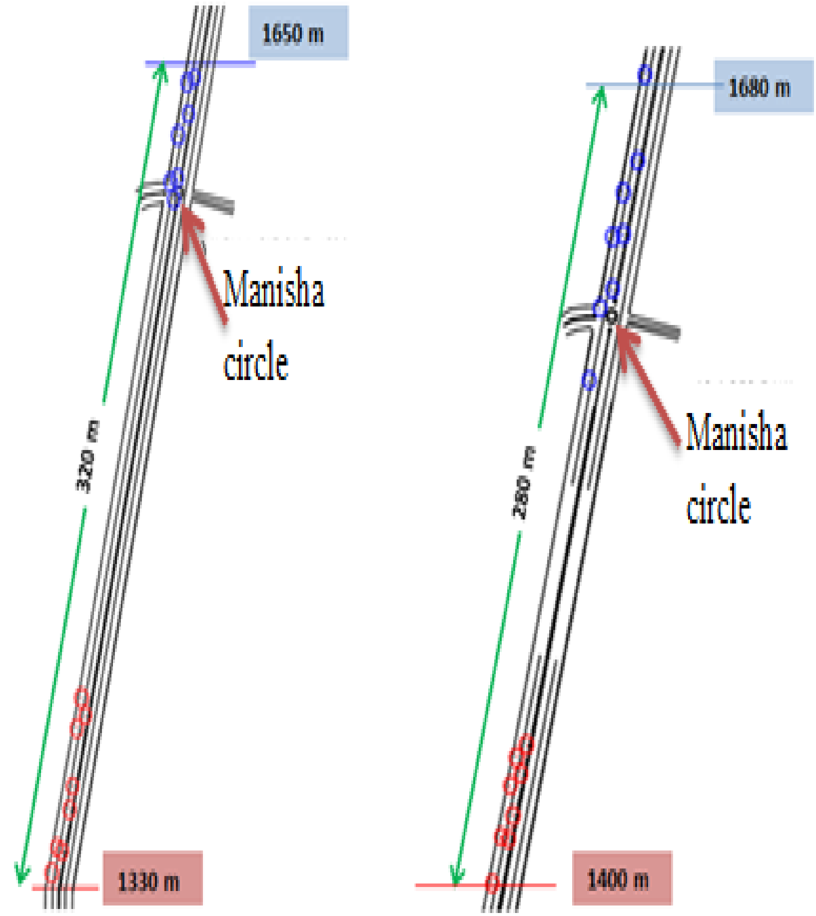
Simulation results



Driving cycle profile for actual data and simulated data



Distance – time and speed – time trajectory for influence zone



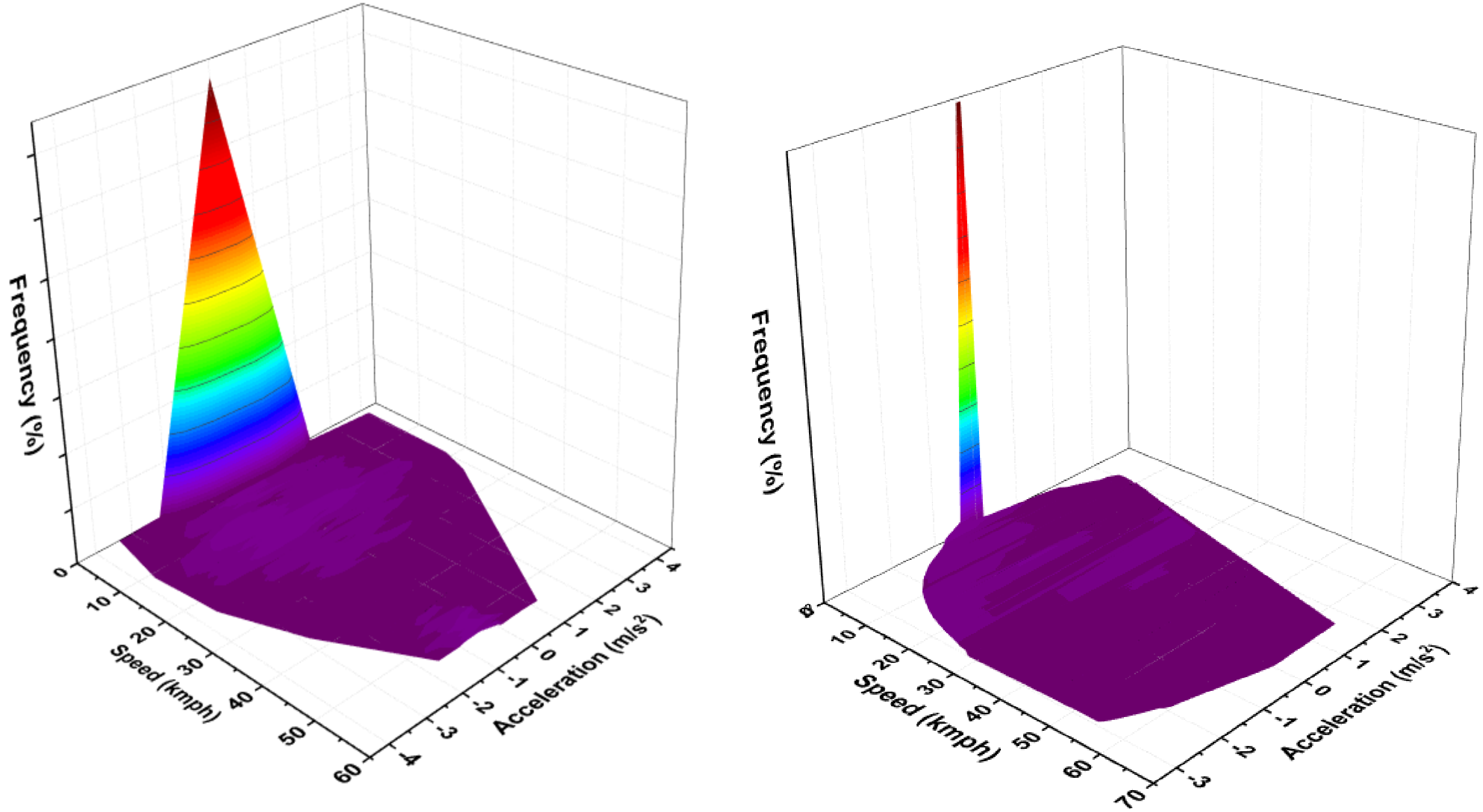
Influence zone for Base data and simulated data

Speed – Acceleration Frequency Matrix for Collected Data

Acceleration (m/s^2) → Speed(kmph)↓	-4 to -3	-3 to -2	-2 to -1	-1 to -0.1	-0.1 to 0.1	0.1 to 1	1 to 2	2 to 3	3 to 4	4 to 5	Total
0 - 5	0.001	0.003	0.003	0.002	0.616	0.002	0.003	0.003	0.000	0.001	0.633
5 - 10	0.000	0.003	0.009	0.014	0.004	0.012	0.008	0.003	0.001	0.000	0.055
10 -15	0.001	0.000	0.015	0.013	0.000	0.010	0.009	0.004	0.001	0.000	0.053
15 - 20	0.004	0.009	0.014	0.015	0.003	0.016	0.012	0.007	0.003	0.000	0.082
20 - 25	0.003	0.004	0.011	0.011	0.003	0.011	0.007	0.003	0.002	0.000	0.056
25 - 30	0.001	0.004	0.005	0.010	0.002	0.008	0.003	0.003	0.000	0.000	0.036
30 - 35	0.000	0.001	0.006	0.006	0.001	0.002	0.002	0.001	0.000	0.000	0.018
35 - 40	0.000	0.001	0.006	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.010
40 - 45	0.000	0.001	0.006	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.009
45 - 50	0.000	0.000	0.006	0.009	0.000	0.002	0.000	0.000	0.000	0.000	0.016
50 - 55	0.000	0.000	0.006	0.016	0.004	0.005	0.001	0.000	0.000	0.000	0.033
55 - 60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65 - 70	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	0.009	0.026	0.088	0.099	0.633	0.068	0.045	0.024	0.007	0.001	1.000

Speed – Acceleration Frequency Matrix for Simulated Data

Acceleration (m/s²) → Speed (kmph) ↓	-4 to -3	-3 to -2	-2 to -1	-1 to -0.1	-0.1 to 0.1	0.1 to 1	1 to 2	2 to 3	3 to 4	4 to 5	Total
0 - 5	0.000	0.000	0.009	0.021	0.734	0.006	0.006	0.004	0.000	0.000	0.780
5 - 10	0.000	0.003	0.008	0.000	0.000	0.000	0.000	0.007	0.002	0.000	0.019
10 -15	0.000	0.010	0.000	0.000	0.000	0.002	0.004	0.005	0.000	0.000	0.021
15 - 20	0.000	0.008	0.000	0.000	0.017	0.008	0.004	0.004	0.000	0.000	0.041
20 - 25	0.000	0.008	0.000	0.000	0.000	0.000	0.002	0.008	0.000	0.000	0.018
25 - 30	0.001	0.007	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.000	0.016
30 - 35	0.000	0.005	0.002	0.003	0.006	0.010	0.006	0.003	0.000	0.000	0.036
35 - 40	0.000	0.004	0.000	0.000	0.000	0.004	0.004	0.002	0.000	0.000	0.013
40 - 45	0.000	0.004	0.000	0.000	0.000	0.000	0.002	0.003	0.000	0.000	0.009
45 - 50	0.000	0.004	0.000	0.000	0.000	0.002	0.005	0.000	0.000	0.000	0.012
50 - 55	0.000	0.004	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.010
55 - 60	0.000	0.004	0.001	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.011
65 - 70	0.000	0.000	0.002	0.003	0.003	0.000	0.006	0.000	0.000	0.000	0.014
Total	0.001	0.060	0.023	0.027	0.759	0.032	0.053	0.043	0.002	0.000	1.000



Speed – Acceleration frequency for base data and simulation data

Selection of driving cycle

$$\text{SSD} = \sum_{i=1}^{Ns}\sum_{j=1}^{Na}(P_{ij} - Q_{ij})^2$$

Parameters	%Acceleration	%Deceleration	% Idle	SSD
Base Cycle	14.47	22.26	61.56	
Simulated Cycle - 1	15.05	14.07	68.49	0.407
Simulated Cycle - 2	13.01	11.06	73.35	0.018
Simulated Cycle - 3	12.09	12.48	75.3	0.981
Simulated Cycle - 4	45.39	41.99	4.85	1.300
Simulated Cycle - 5	33.45	38.79	25	1.105
Simulated Cycle - 6	45.13	38.24	9.26	1.296

DISCUSSION

- In present study traffic simulation modelling is done in VISSIM software.
- The speed time profile generated from simulation results is compared with collected base data.
- The speed time profile of simulation shows linear slope of acceleration with respect to time, where as in base data it fluctuates with time.
- To generate speed acceleration frequency matrix, a code has been developed in C#.
- Intersection influence zone is identified from deceleration activity to idle and acceleration.
- Three driving parameters; percentage acceleration time, percentage deceleration time and percentage idle time are calculated for influence zone.
- Driving cycle from simulation results are compared with the base data and selected by least sum square difference of speed-acceleration classes.

References

1. Abhisek Mudgal. *Modeling Driving Behavior at Traffic Control Devices*. Graduate Theses and dissertations, Iowa State University, 1-114, 2011.
2. Blacksburg, Virginia. *A reference book of driving cycle for use in measurement of road vehicle emissions*. Published Project Report PPR 354, 1-284,2009.
3. Byungkyu Park, J.Schneeberger. Microscopic Simulation Model Calibration and Validation: Case Study of VISSIM Simulation Model for a Coordinated Actuated Signal System. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 1856, 2003, pp. 185-192
4. H. Sebastian Buck, Nicolai Mallig and Peter Vortisch. Calibrating Vissim to Analyze Delay at Signalized Intersections. *Transportation Research Record: Journal of the Transportation*, Volume 2615, 2017DOI: 10.3141/2615-09.
5. Hatem Abou-Senna, Essam Radwan, Kurt Westerlund, and C. David Cooper. Using a traffic simulation model (VISSIM) with an emissions model (MOVES) to predict emissions from vehicles on a limited-access Highway. *Journal of the Air & Waste Management Association*, 63(7), 2013, 819–831.
6. Int Panis, L., S. Broekx, and R. Liu. Modelling instantaneous traffic emission and the influence of traffic speed limits. *Science of the Total Environment*, 371 (1–3), 2006,270–285.
7. Jiun-HorngTsai, Hung-Lung Chiang,Yi-Chun Hsu, Bo-Jun Peng, Rong-Fang Hung. Development of a local real world drivingcycle for motorcycles for emission factor measurements. *Atmospheric Environment* 39, 2005, 6631–6641.

Continued.............

8. John B. Partin, Tim O. Moore, Wakeel Idewu. Comparison of measured and modeled vehicle emissions for advance prediction of air quality and NO_x exposure level. *International Journal of Engineering Research and Technology*, 4(12), 2015, 91-97.
9. K.S. Nesamani, K.P. Subramanian. *Impact Of Real-World Driving Characteristics On Vehicular Emissions*. Institute of Transportation Studies, University of California, Irvine UCI-ITS-WP-05-5, 2005,1-31.
10. K.S. Nesamani, K.P. Subramanian. Development of a driving cycle for intra-city buses in Chennai, India. *Atmospheric Environment*, 45, 2011, 5469-5476
11. Karin Brundell-Freij and Eva Ericsson. Influence of street characteristics, driver category and car performance on urban driving patterns. *Transportation Research Part D: Transport and Environment,* 10(3), 2005, 213-229.
12. Koh S.Y Doina and Chin H.C.*Traffic Simulation Modeling: VISSIM*. A report on VISSIM, 1-11
13. Kun CHEN, Lei YU. Microscopic traffic-emission simulation and case study for evaluation of traffic control strategies. *Journal of transportation systems engineering and information technology*, 7(1), 2017, 93-99.
14. Kyoungho Ahn. *Microscopic fuel consumption and emission modelling*. Thesis of Master of Science In Civil and Environmental Engineering, Blacksburg, Virginia, 1998, 1-141.

Continued…………..

15. Lei Yu, Ziqianli Wang, and Qinyi Shi. *PEMS-based Approach to Developing and Evaluating Driving Cycles for Air Quality Assessment*. Report SWUTC/10/169300-1, 2010, 1-94.
16. Li Jie. Henk Van Zuylen. Yusen Chen, Francesco Viti, Isabel Wilmink. Calibration of a microscopic simulation model for emission calculation. *Transportation Research Part C*: *Emerging Technologies*, 31, 2013, 172-184.
17. Martin Fellendorf and Peter Vortisch. *Microscopic Traffic Flow Simulator VISSIM*. International Series in Operations Research & Management Science 145, 2010, 63-93
18. Meng Li, Kanok Boriboonsomsin, Guoyuan Wu, Wei-Bin Zhang, and Matthew Barth. Traffic Energy and Emission Reductions at Signalized Intersections:A Study of the Benefits of Advanced Driver Information. *International Journal of ITS Research*, 7(1), 2009, 49-58.
19. Michel Andre, Ulf Hammarstrom, Isabelle Reynaud. *Driving statistics for the assessment of pollutant emissions from road transport*. INRETS Report LTE 9906,1999, 1-194
20. Mohammad Syafrizal, Estelle Bretagne, Nadia Hamani, Bambang Sugiarto, Setyo Sarwanto Moersidik. *Jakarta driving cycle and emission factors: analysis in the case of Semanggi intersection*. Transport Research Arena 2014, 2014, Paris, 1-10.

Continued……….

21. P.Fernandes, M.C.Coelho, N.M. Rouphail. Assessing the impact of closely-spaced intersections on traffic operations and pollutant emissions on a corridor level.
22. Prashant Shridhar Bokare, Akhilesh Kumar Maurya. Study of effect of speed, acceleration and deceleration of small petrol car on its tail pipe emission. *International Journal for Traffic and Transport Engineering, 3(4), 2013, 465 – 478.*
23. *PTV VISSIM 8 User Manual*. PTV AG, Haid-und-Neu-Str. 15, 76131 Karlsruhe, Germany, 2015.
24. Rebecca Haley, Sarah Ott, Joseph Hummer, Robert Foyle, Christopher Cunningham, Bastian Schroeder. Operational Effects of Signalized Superstreets in North Carolina. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2223, 2011, pp. 72-79
25. S. Tamsanya, S. Chungpaibulpatana and B. Limmeechokchai. Development of a driving cycle for the measurement of fuel consumption and exhaust emissions of automobiles in Bangkok during peak periods. *International Journal of Automotive Technology*, 10(2), 2009, 251−264.
26. Sanghpriya H. Kamble, Tom V. Mathew, G.K. Sharma. Development of real-world driving cycle: Case study of Pune, India. *Transportation Research Part D Transport and Environment*, 14(2), 2009, 132-140.

CONTINUED……….

27. Sukanya Tamsanya, Supachart Chungpaibulpattana,Surat Atthajariyakul. *Development of Automobile Bangkok Driving Cycle for Emissions and Fuel Consumption Assessment*. The 2nd Joint International Conference on "Sustainable Energy and Environment, Bangkok, Thailand, 2006, 1-6.
28. Srinath Mahesh, Gitakrishnan Ramadurai, *Review of transport-related emission estimation studies*. A review report, 1-10
29. Uditha Galgamuwa, Loshaka Perera, Saman Bandara. Developing a General Methodology for Driving Cycle Construction: Comparison of Various Established Driving Cycles in the World to Propose a General Approach. *Journal of Transportation Technologies*, 5, 2015, 191-203.
30. W.T. Hung, H.Y. Tong, C.P. Lee, K. Ha, L.Y. Pao. Development of a practical driving cycle construction methodology: A case study in Hong Kong. *Transportation Research Part D* 12, 2007, 115–128.

Thank you