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STUDY OF TRAFFIC CHARCTERSTICS OF SELECTED JUNCTIONS IN CHANDIGARH THROUGH SIMULATION

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ABSTRACT

In India, the traffic is of mixed composition and the rate of growth of traffic is very high, but the resources available for giving this growth a suitablebaseare limited. So the only option left is to make the present facilities highly efficient. The present study aims to study the traffic flow at a junction in Chandigarh using simulation techniques. It is aimed to increase the efficiency of the junction by providing one of the component of Intelligent Transport System, VAP (Vehicle Actuated Programming) signals i.e. variation of the signal timings according to the variation in traffic demand. This has been accomplished with the help of simulation through detectors used in the VISSIM software along with its add-on module VisWalk (for pedestrian movements). This study elaborates the interaction of vehicles and pedestrians while using junction facilities through Simulation in VISSIM.

Keywords: Roundabout, Simulation, VAP, Signal, Pedestrian.

1.BACKGROUND

Transportation today plays an important role in the economic and physical development of any modern city. There is a rapid increase in the number of the vehicles and their varieties on the Indian roads which creates a complex problem for the transportation professionals. As such type of traffic flow consists of a wide range of complex activities, embracing vehicle arrivals, speed of travel, lane discipline, overtaking, mixed traffic flow and crossing logic, gap acceptance, acceleration and deceleration etc. Today, many micro-simulation software has been developed and used as tools for the evaluation of traffic management and control. Released in 1992, VISSIM is a microscopic, time step and behaviour based simulation model developed to model urban traffic and public transit operations. VISSIM in German means “Traffic in Towns: Simulation”.

The VISSIM B consists of combination of two software i.e. VISSIM and Viswalk. VISSIM deals with the study of the traffic, while Viswalk deals with the traffic study related to pedestrians. In this software, in a single model, both pedestrian and traffic can be studied simultaneously. The VISSIM is used

for the evaluation and planning of urban and extra-urban transport infrastructure. This simulation software is also used to create detailed 3D animations for showcasing purpose and running 3D simulations. With links and connectors, the users can model geometries with any level of complexities. It includes the options for setting attributes for the driver behaviour and vehicle characteristics. PTV VISSIM is a microscopic simulation program for modelling multimodal transport operations. Realistic and accurate in every detail, VISSIM creates the best conditions for testing different traffic conditions before their actual realization.

Viswalk is used to model and simulate the human walking behaviour. It is used at those locations wherever there is the need for pedestrian simulation and analysis is to be done. The design of the facilities is done for the pedestrians like escalators, footpaths, road crossings, ramps, stairs, railway stations, shopping complexes, malls, hospitals, banks, cinema halls, sports stadiums, and any other public gatherings where the pedestrian traffic is very high. Based on the Social Force Model by Prof. Dr. Dirk Helbing, it reproduces the human walking behaviour realistically and reliably. This software consists of features which is used, when it is necessary to simulate and analyse pedestrian flows, be it outdoors or indoors. Viswalk is designed for all those who wish to take into account the needs of pedestrians in their projects or studies, for example for traffic planners and traffic consultants, architects and owners of publiclyaccessible properties, event managers and fire safety officers.

The main advantages of the simulation is that it is cheaper than many forms of field traffic experimentation and less laborious than analytical modelling, in terms of time, resources and cost, it can compare number of alternate strategies and improvement plans.The traffic engineer gains a better insight of traffic characteristics, predict the performance of the system, simulation of traffic system can be done through VISSIM by changing various complex variables to study their influence on the model and it is user friendly in the sense that anyone can understand the traffic through model simulation (Kadiyali 2103). The variety of strategies itself and parameter settings of each single strategy cannot be tested in field trials due to vast number of possibilities, limitations of the present controllers, legal restrictions and acceptance by the users. Simulation has proven to be a valuable tool in case of such restrictions. The accuracy of data which in the model can be improved by the repetition of calibration. The calibration step is the one of the most time consuming process in the simulation.

Vehicles are moving in the network using a traffic flow model. The quality of the traffic flow model is essential for the quality of the simulation. In contrast to simpler models, which largely consists of a constant speed and a deterministic car following logic are provided, VISSIM uses the psycho-physical perception model developed by Wiedemann (1974). The basic concept of this model is that the driver of a faster moving vehicle starts to decelerate as it reaches its individual perception threshold to a slower moving vehicle. Since he/she cannot exactly determine the speed of that vehicle, his/her speed will fall below that vehicle's speed until he/she starts to slightly accelerate again after reaching another perception threshold. There is a slight and steady acceleration and deceleration. The different driver behaviour is taken into consideration with distribution functions of the speed and distance behaviour.

The car following model has been calibrated through multiple measurements at the Institute of transport studies of the Karlsruhe Institute of Technology (since 2009 KIT – Karlsruhe Institute of Technology), Germany. Recent measurements ensure that changes in driving behaviour and technical capabilities of the vehicles are accounted for. For multi-lane roadways a driver in the VISSIM model takes into account not only the vehicles ahead, but also the vehicles in the two adjacent lanes. In addition, a signal control for about 100 meters before reaching the stop line leads to increased attention of the driver. VISSIM simulates the traffic flow by moving driver-vehicle-units through a network. Every driver with his specific behaviour characteristics is assigned to a specific vehicle. As a consequence, the driving behaviour corresponds to the technical capabilities of his/her vehicle. A model which accurately represents the design and operational attributes of the study stretch in the simulation software is known as the 'base model' (Bains et al. 2012). VISSIM B can simulate a Square area of 1.5 km X 1.5 km.

2. LITERATURE REVIEW

Fellendorf (1994) concentrated on the abilities of VISSIM, as a simulation tool for signal control. Signal control study is done by taking many factors into consideration related to the Driver Vehicle Element (DVE) and measured the travel time of each vehicle for the section between the two detectors, thus able to calculate waiting time. Designed the vehicle actuated signals (the signal varies with respect to the flow detected by the detectors), and also drawn the green time histogram for a traffic flow at any particular time which is easy to understand.

Doina and Chin (2007) evaluated the merits and demerits of VISSIM when setting up the network, for simulation, evaluation and presentation. These are measured in terms of time taken to complete the task, information provided by the manual, easy understanding, usefulness, sensitivity, experience based. The study is conducted on the Queenstown network in Singapore which consists of three arterial roads, one secondary access road, two signalized junctions and five signalized junctions, this network is coded in VISSIM and simulation modelling is done on it.

Bonisch and Kretz (2009) compared and measured travel times of the pedestrians at a varying demand jam sizes of vehicles as well as pedestrians in VISSIM simulation. The interaction zone is modelled as a "conflict area" for pedestrian-vehicle interaction. Shown through Figure 1 the dependency of pedestrians travel times on pedestrian demand for various vehicle travel times.

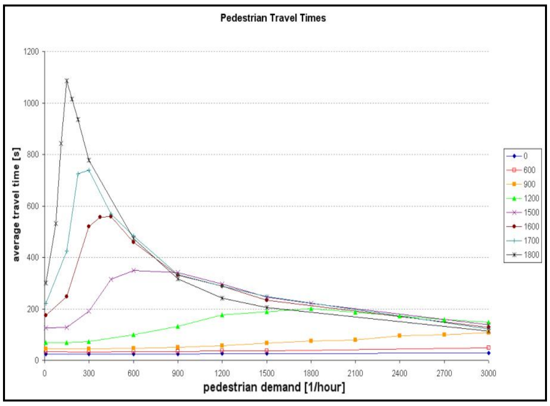

Figure 1: Dependency of Pedestrian travel time

Zha et al. (2010) done the research to investigate the Downstown Space Reservation System (DSRS), using VISSIM. This approach is used to mitigate the traffic congestion in an urban area. It has been found out in the simulation modelling that DSRS can markedly improve traffic conditions especially in an area with high congestion levels and the magnitude of the improvement in performance increases with increasing demand levels.

Bergman et al. (2011) had investigated and compared the model by Rodegerdts and Blackwelder with simulation model in VISSIM and measurements are taken from the Swedish roundabouts. When the vehicle flow and pedestrian flow in roundabout were increased or decreased in the micro simulation it was noticed that a high vehicle flow seemed to be more affected by small changes in the pedestrian flow. It is also concluded that, if the vehicle flow was lower, a high pedestrian flow did not affect it much.

Bains et al. (2012) determined the PCU of the different types of the vehicles on the Mumbai-Pune Expressway in Western India by doing simulation in the VISSIM software. The PCU value which is generally a dependent variable, and determined by changing different variables like lateral clearance, vehicle flow, traffic composition, driver behaviour etc. according to the Indian condition in VISSIM. It has been found that PCU decreases with increase in volume-capacity ratio irrespective of vehicle category. The study also revealed that at a given volume level, the PCU of a given vehicle category decreases when its own proportion in the stream increases.

Based on characteristic and conflict scenes, analysis of pedestrian and vehicle behaviours at isolated signalized intersection, the Gao et al. (2012) described pedestrian and vehicle behaviour rules by taking the advantage of VISSIM software by using big intersection in Beijing as a simulation case. It is concluded that reasons that lead to pedestrian and vehicle delay is insufficient pedestrian crossing time.

Liu et al. (2012) proposed to help in modelling U-turn movements at un-signalized intersection with non-traversable median cross sections in the traffic simulation program VISSIM. A procedure based on a genetic algorithm was used to calibrate and validate VISSIM simulation model. The calibrated VISSIM simulation model yields mean absolute percent error values of 17.6% and 20.7% four-lane and six-lane streets, respectively. This model provides a reasonable capacity estimates for U-turns at un-signalized intersections with raised median cross sections.

PTV VISSIM Copenhagen (2012) had done the simulation and evaluation of the measures like development of new infrastructure, green waves, parking areas and increased capacity on frequently used cycle paths in the city of Copenhagen using the PTV VISSIM software. For the proper understanding the behaviour of the cyclists at peak hours was taken into consideration. They collected the data, process it and validate it and then able to translate it into valid parameters in order to simulate the bicycle traffic in VISSIM.

PTV VISSIM Eelup (2012) had upgraded the Eelup Roundabout, which is considered as black spot before the up-gradation. The roundabout is signalised with VisVAP. After up-gradation, traffic flow had become that much efficient that queues that used to stretch back for whole kilometres every morning are now a thing of the past, the accidents are reduced to 50 from 150 and there is an annual cost saving of 2 million dollars per year.

Galiza and Ferreira (2013) introduced the concept of standard pedestrian equivalent factors as a practical systematic methodology for dealing with heterogeneity in pedestrian flow by using micro simulation and generated the corresponding flow relationships. The physical and operational characteristic of pedestrians, particularly body sizes and walking speeds were varied for different flow conditions, walkway widths, and proportions of other pedestrian types were varied while doing the simulation and their results are studied. The micro simulation tool VISSIM pedestrian module (VisVAP) has been employed to evaluate the effects of pedestrian heterogeneity.

Kim et al. (2013) presented a means to design the pedestrian operation and plan on the basis of the estimated number of people. The simulation model in VISSIM was developed which captures important details such as travel time, wait time and queue length. The simulation model was replicated accurately with the video captured in real-time. The main contribution of this paper is that by using a micro-simulation model, pedestrian movement in various buildings like cinema halls, banks, railways, supermarkets, airports, metros etc. can be estimated without a significant cost.

Gallelli et al. (2014) studied the effect of roundabout geometrics (entering flow, circulating flow, entry curvature, entry path radius, entry width, approach width, ratio of inscribed circle diameter/ central island diameter, angle to next leg, etc.) on the crossing movements, by the use of VISSIM micro-simulation software. Results concern the following issues: (i) coherence validation of experimental data regarding speed distributions along the crossing movement as a function of roundabout radius, (ii) to understand the effects of the change of roundabout geometric features on simulation results.

3. METHODOLOGY

The comparison is made between the observedflow and VAP simulated flow of roundabout. This difference will give us the value of the flow to which the present traffic flow can be enhanced without dimensional changes, by using VAP equipped signals.

The steps to be followed here are setting the study area requirements, site selection, data collection, analysis of data, model generation, simulation of the model, collecting data in the simulated model, comparison with actual conditions.

3.1 SITE SELECTION

Site selected for the present study is located in Chandigarh, along Dakshin Marg on junction named Medical Chowk. This Chowk forms the intersection of Dakshin Marg and Chandi Path as shown in Figure 2, Google earth view of considered rotary. The reason for selecting this roundabout is that there are all required facilities available for the pedestrians like raised road crossing, pedestrian signal, signs etc. Central island having diameter 49.8m, all the dimensions of the rotary are shown through cad drawing inFigure 3 and all the traffic signal posts are provided on the central island except the pedestrian signal posts on every corner of the junction. The approaches of the rotary are designated as A, B, C and D. Length of each approach shown is around 200m in cad drawing.

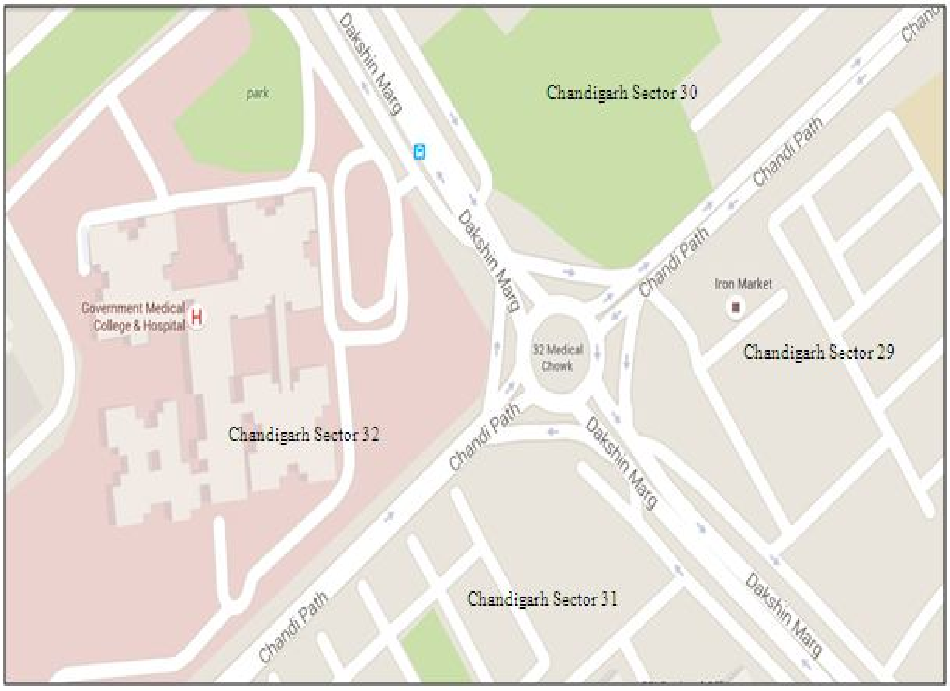

Figure 2: Study area in Chandigarh

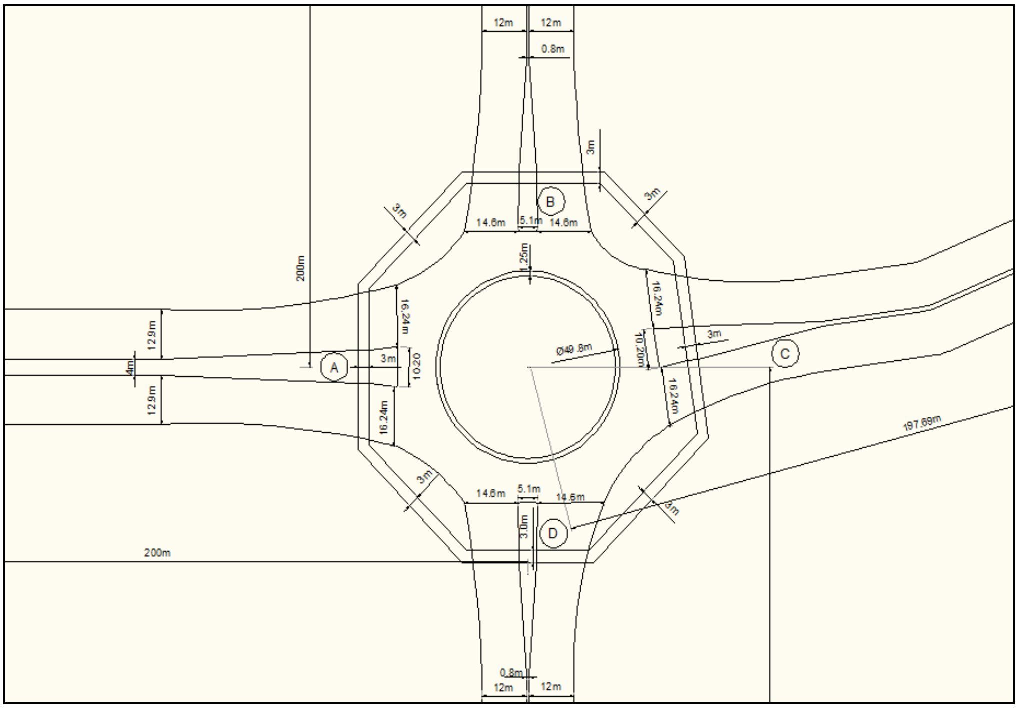

Figure 3: Study area with dimensions

3.2 DATA COLLECTION

The data collected for the purpose of coding model requires the flow of vehicles entering the rotary and flow of vehicles leaving the rotaryfrom each arm. Data collection includes the recording of total flow of vehicles of each class like two-wheelers, cars, buses or trucks (single axle), tandem-axle vehicles and tridem-axle vehicles. The flow of pedestrians crossing road is also recorded with their different classes like woman, man, cycles. The data collection is generally carried out with the assistance of video cameras for one hour. The data is collected by putting cameras on each approach, so that the number of vehicles entering and leaving the roundabout can be recorded. The data is then converted from the video into tabular form by manually counting the vehicles in the video by playing video at low speed. The data collection includes the measurement of physical features of the roundabout. The Table 1 shows the traffic data collected on the Medical Chowk. Table 2 shows the pedestrian data also collected through video cameras on Medical Chowk.

The data collection is made during the peak hour so that we can get the maximum flow of vehicles and pedestrians. The time of the day during which the data is collected is in the morning from 9:00 AM to 10:00 AM. As the selected roundabout is located near a Medical Hospital, which generates enough pedestrian flow and Medical Hospital acts like a source of attraction for pedestrian traffic on rotary in the morning.

Table 1: Traffic Data collected on Medical Chowk

Sr. No.	Vehicle Class	Entry approaches				Exit approaches				Total Vehicles
		A	B	C	D	A	B	C	D	
1.	Two-wheelers	1520	762	1158	566	1263	947	962	834	4006
2.	Cars	1147	574	1061	425	961	722	889	635	3207
3.	Single Axle vehicles (Bus/Truck)	89	44	124	33	82	56	103	49	289
4.	Tandom Axle vehicles	0	0	1	0	0	0	1	0	1
5.	Tridem/Multi- Axle vehicles	0	0	0	0	0	0	0	0	0
Total Flow (Veh/hr)		2756	1380	2344	1024	2306	1725	1955	1518	7503

Table 2: Pedestrian data collected on Medical Chowk

SR. No.	PedestrianType	Approaches					Total Pedestrians
		A	B	C	D		
1.	Man	83	50	95	40		268
2.	Woman	33	20	26	17		96
3.	Cyclists	5	3	18	2		28
Total Flow (Vehicles/hour)		121	73	139	59		392

3.3 MODEL GENERATION

Model generationwas done in different stages. Firstly, all the dimensional, traffic and pedestrian data was collected from the present study roundabout. Then model wascodedin VISSIM software with all the possible similarities. Traffic signals, stop lines, road crossings were provided on their respective locations. This model was then feed with all the traffic data and pedestrian data collected at study location. The model is created with background of study location taken from Google Earth. The model generation is initialized with the help of creating links and nodes. All physical features of the roundabout are created in the model. The vehicle input parameteris added on each incoming approach with their relative flows in accordance with proportion of each vehicle class. Then vehicle routes were provided to each incoming approach, because VISSIM makes flow of vehicle only in one direction. Then signal controllers were created and VAP signals were programmed through this option. Data collection points were mentioned on each outgoing approach and evaluation menu was used for selecting options like up to what simulation time the data is needed to collected, what data is to be shown in result list and in what form the data collection results were needed. The data collection results were written in file or it is written in database. Then simulation parameters were set as per requirement, for example simulation has to be run at the rate of 10simulation/sec. Then simulation is made to run for 3600 secs and all the data is collected in the form of excel files.

While working with VAP the file names pau and vap are required to be created by using notepad and VISVAP 2.16. Figure 4 and Figure 5 shows the picture of vap files and pau files respectively. The pau file includes the signal groups with their timings and vap file includes the logic which acts like a mainframe for the functioning of VAP signals. In pau files-127 indicates that signal remains green before the interstage begins and 127 indicates that signal remains green after the interstage begins. For creating VAP signals the minimum green time,for traffic signal group and pedestrian signal group is very essential. Minimum green time lets the flow of vehicle to take place even if the number of pedestrian traffic increases.

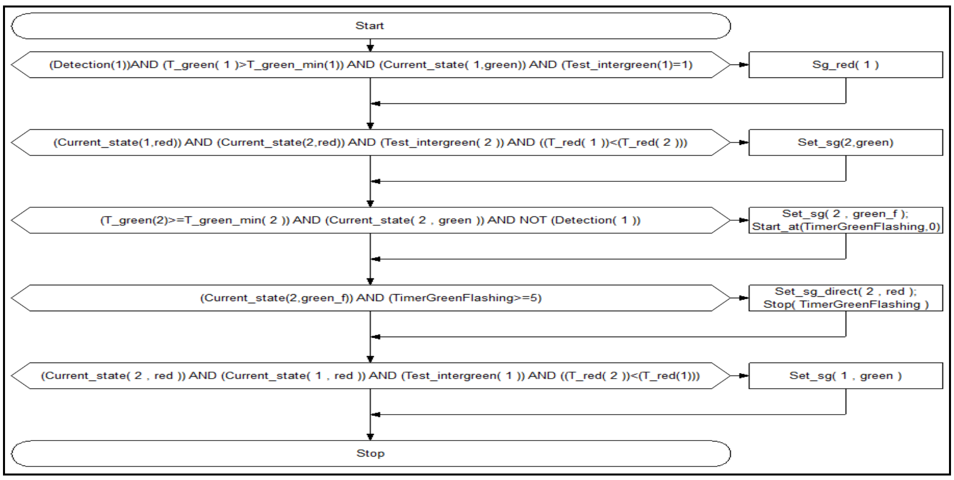

Figure 4: Logic for VAP signals

```
$SIGNAL_GROUPS
$
K1          1
k2          2

$IGM
$
            K1          K2
K1          -127        4
K2          4           -127

$STAGES
$
stage_1 K1
red         K2
stage_2 K1
red         K2

$STARTING_STAGE
$
stage_1

$END
```

Figure5: Coding for creating pau files

VAP signal functioning has been shown in Figure 6 to Figure 9. The VAP signal functioning can be seen in simulation, in which the traffic flow goes on passing until the pedestrian comes under the area of detection, the traffic light changes automatically to the minimum green time when it detects some pedestrians under its influence. The minimum green time changes to the red automatically after the completion of minimum green time.

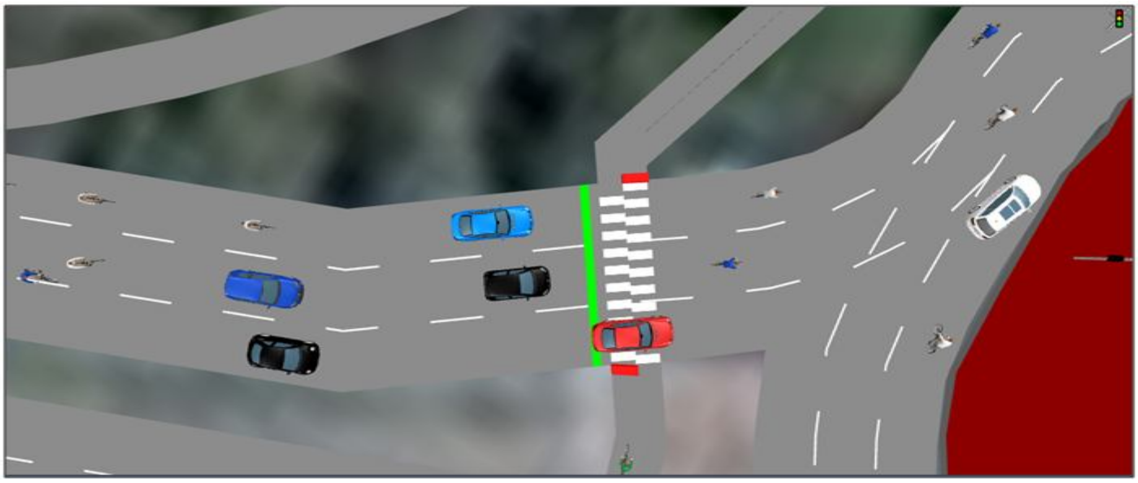

Figure 6: Vehicles crossing the VAP signals

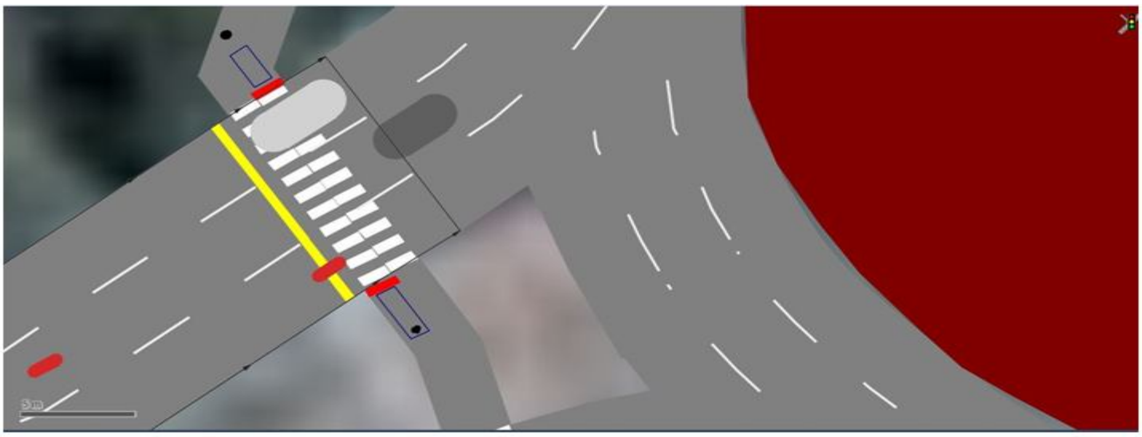

Figure 7: Traffic signal changes automatically when pedestrian signal detects the pedestrian

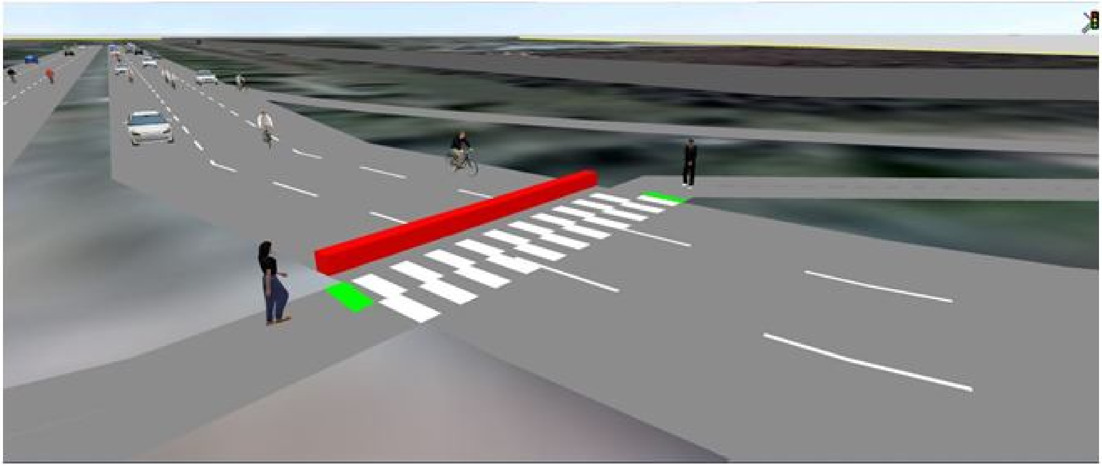

Figure 8: Persons crossing the road from opposite directions

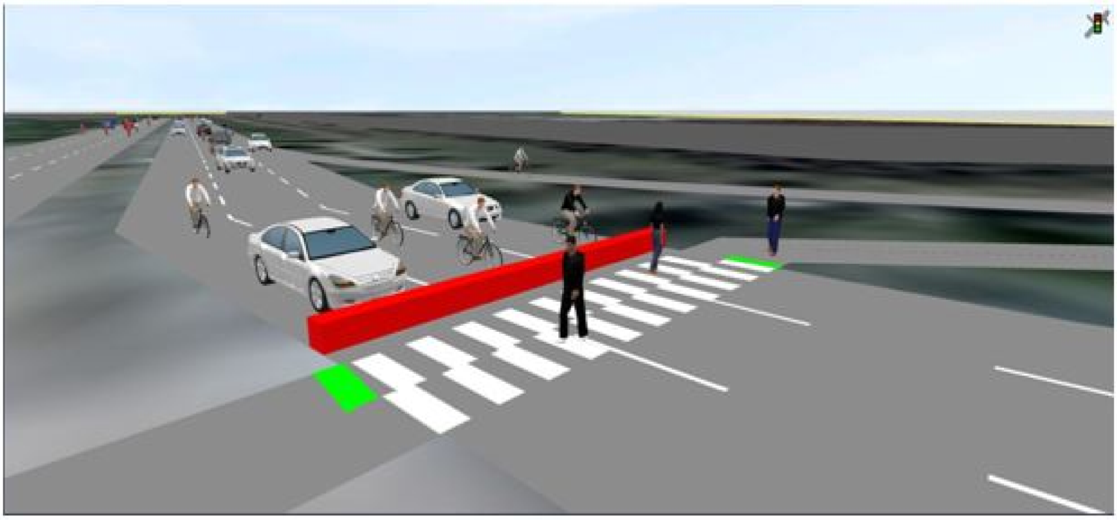

Figure 9: Pedestrian signal remains green for minimum green time

4.DATA COMPARISON AND RESULT

The comparison is made between the actual data collected at the exit approaches in field with the simulated data collected at exit approaches of the VISSIM model. In Table 3 and Table 4, As, Bs, Cs and Ds represents the simulated outflow and Aa, Ba, Ca and Darepresents the actual measured outflow, from the respective approaches of vehicles and pedestrians respectively. The simulated data is collected in the network with the help of the data collection points which are fixed on each exit approach. Then the comparison is made between the actual outflow of the vehicle and the simulated outflow of the vehicle in terms of percentage increase or decrease.

Total simulated vehicular flow handled by the rotary with VAP signals has been found as 9128 vehicles/hour, whereas actual vehicular flow handled by the rotary with fixed signals comes out to be 7504 Vehicles/hour. So the percentage rise in the vehicular flow is 21.64 percent.

Similarly, total simulated pedestrian flow with VAP signals is obtained as 431 pedestrians/hour and total pedestrian flow with fixed signals comes out as 392 pedestrians/hour. So the percentage rise in the pedestrian flow is found as 10 percent.

Table 3: Vehicular data Comparison on Medical Chowk

SR. No.	Vehicle Class	Exit approaches							
		A_s	A_a	B_s	B_a	C_s	C_a	D_s	D_a
1.	Two wheelers	1 280	1 263	1 077	9 47	1 077	9 62	1 227	8 34
2.	Cars	1 200	9 61	8 96	7 22	1 003	8 89	9 31	6 35
3.	Single Axle Vehicles (Bus/Truck)	1 06	8 2	7 7	5 6	1 51	1 03	9 6	4 9
4.	Tandom Axle Vehicles	1	0	1	0	3	1	2	0
5.	Tridem/Multi-Axle Vehicles	0	0	0	0	0	0	0	0
Total Flow (Veh/hr)		2 587	2 306	2 051	1 725	2 234	1 955	2 256	1 518

Table 4: Pedestrian data Comparison on Medical Chowk

SR. No.	PedestrianType	Approaches							
		A_s	A_a	B_s	B_a	C_s	C_a	D_s	D_a
1.	Man	8 9	8 3	5 8	5 0	9 9	9 5	4 4	40
2.	Woman	3 5	3 3	2 3	2 0	2 7	2 6	1 9	17
3.	Cyclists	6	5	5	3	2 1	1 8	5	2
Total Flow (Pedestrians/hour)		1 30	1 21	8 6	7 3	1 47	1 39	6 8	59

The comparison between the simulated and the observed actual flow on the approaches is shown through Surface Charts in Figure 10 and Figure 11. These figures show the predominant vehicle class or pedestrian class on whole roundabout and on each approach. The comparison can be compared visually between the traffic flow at different approaches.

Figure 10: Pedestrian Flow Comparison

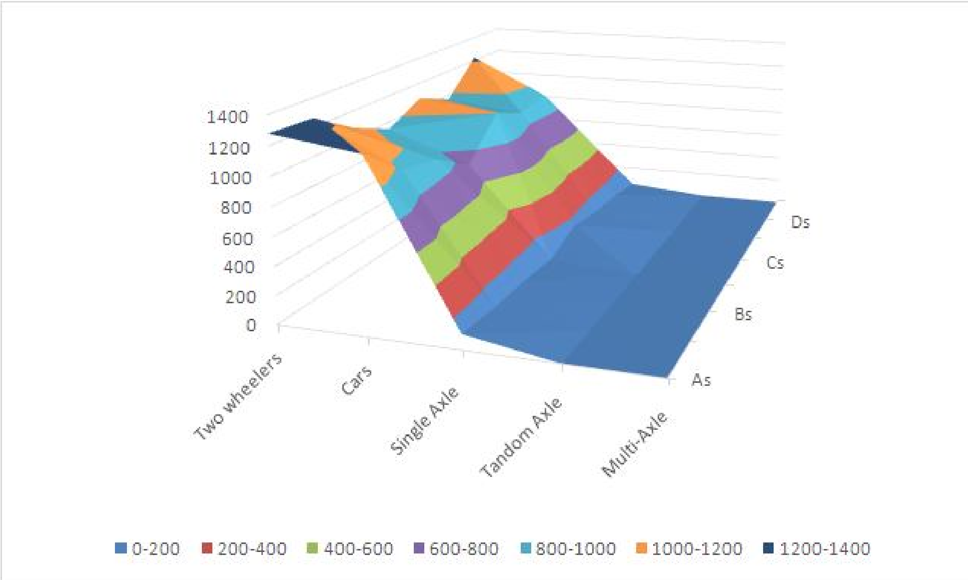

Figure11: Vehicle flow comparison

5.LIMITATIONS

The VISSIM software has some limitations by which it ceases to represents the Indian traffic environmentfully. The limitations which it consists are:-(1) two wheelers in VISSIM are represented only by cycles, as there is nodimensional difference between cycles and bikes. (2) there is no such vehicle class which represents the tri-cycle and auto-rickshaws in VISSIM.

As these limitations affects the behaviour of traffic simulation and the results which are produced by data collection points may also vary from the simulation if taken with actual factors.

6.CONCLUSION AND RECOMMENDATIONS

From the present study, it has been concluded that by using the VAP programmed signal, the efficiency of the roundabout can be increased by certain percentage in terms traffic flow. Consequently, if traffic flow increases, then velocity and density also attains their optimum values. In this study, the vehicular and pedestrian flows have increased by 21.64 percent and 10 percent respectively using simulation tool VISSIM.

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