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A Series of Studies using Microsimulation Suite

Contents

Introduction

Summary of Microsimulation Suite of Programs

GenerateTraffic: Older version of TrafficFlowGenerator- see Colin Caprani's PhD thesis 2005.

TrafficFlowGenerator: Generates source traffic; vehicles, gaps, spaces etc

EvolveTraffic: Takes traffic created by TrafficFlowGenerator and drives vehicles along road

MarchTraffic: Runs traffic (from any of the above programs) over bridge to calculate load effect

Summary of Studies

Study 1:

Comparison between GenerateTraffic & TrafficFlowGenerator (gaps, headways)

Study 2:

Comparison within TrafficFlowGenerator for different percentages of cars generated (gaps, headways)

Study 3:

Finding values of parameters & road configuration which give realistic driver behaviour in EvolveTraffic

Study 4:

Test of convergence in EvolveTraffic (using 1, 2, 3 days of traffic)

Study 5:

Sensitivity study varying parameters in EvolveTraffic

Study 1: Software Verification

The purpose of this study is to compare the gaps and headway in the output from GenerateTraffic and TrafficFlowGenerator. GenerateTraffic is a long established program.

These are two programs designed by Colin Caprani which are used to generate traffic files to be used in EvolveTraffic.

One day of traffic with no cars (as GenerateTraffic only generates trucks) was used for this study.
Both congested and free flowing traffic was studied.

Congested Flow:

The following graphs, all for the same three runs, show data obtained from congested traffic. In the following graphs the green line (GT) represents the data obtained from a file generated using GenerateTraffic. The blue and red lines (TFG & TFG2) represent data obtained from two separate files generated using TrafficFlowGenerator, the new version of GenerateTraffic. These two are simply repetitions to test consistency.

Table 1: Inputs for Congested Files

Distance for which overlaps are prevented (m)	300
No. of days of traffic required	1
Site flow data to be used	2
Site weight data to be used	2
Vehicle buffer size	1000
No lanes in direction 1	2
No lanes in direction 2	0
Nominal congested spacing, front to back (m)	5
congested speed (km/h)	30
Congested gaps coefficient of variation	.05
Headway model to be used	5
Proportion of cars	0

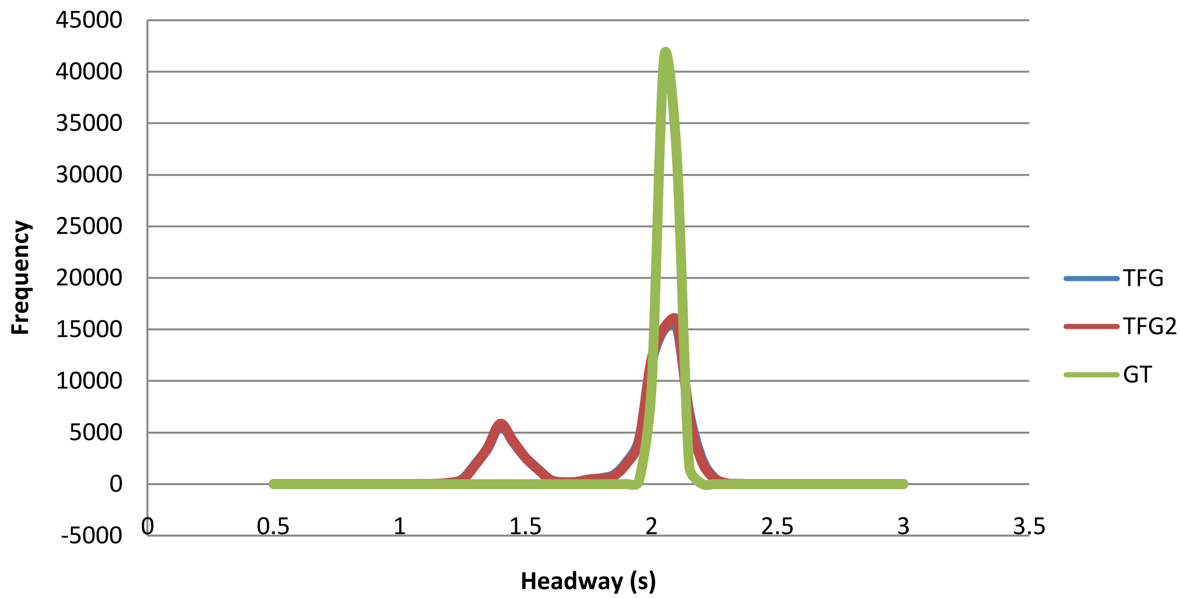

Fig. 1: Congested Headway Graph (s)

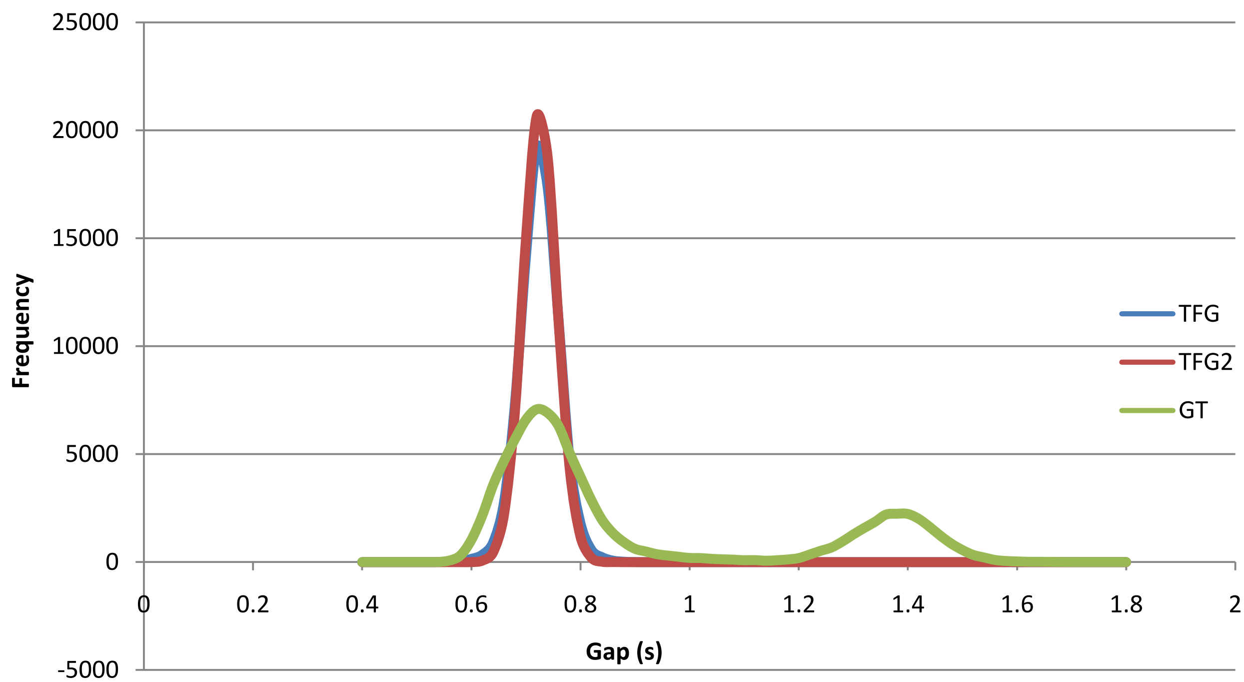

Fig. 2: Congested Gap Graph (s)

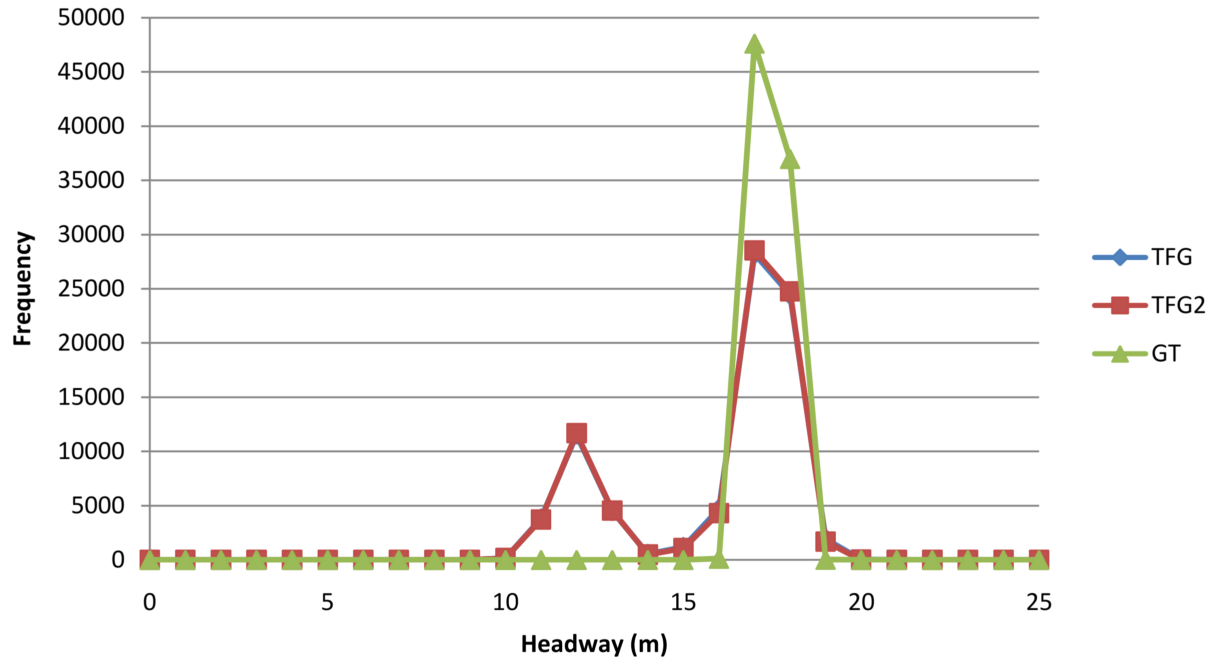

Fig. 3: Congested Headway Graph (m)

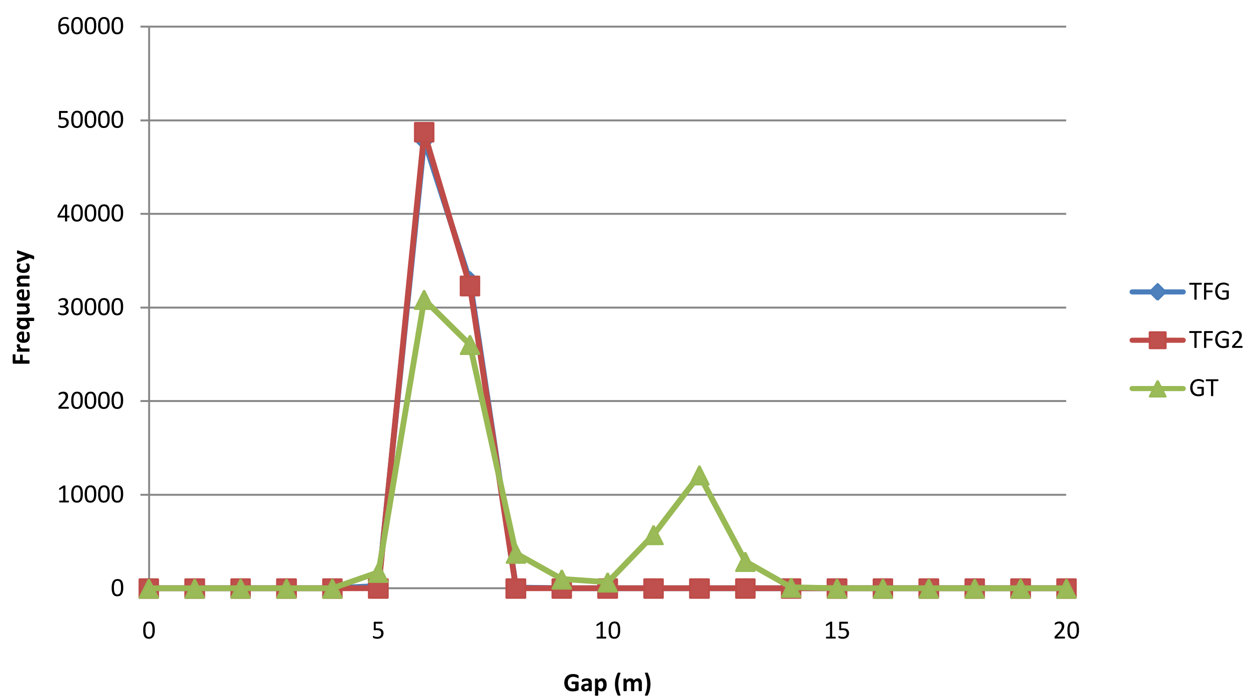

Fig. 4: Congested Gap Graph (m)

Free Flowing:

The following graphs, all from the same three runs, show data obtained from free flowing traffic. In the following graphs the green line (GT) represents the data obtained from a file generated using GenerateTraffic. The blue and red lines (TFG & TFG2) represent data obtained from two separate files generated using TrafficFlowGenerator, the new version of GenerateTraffic. These two are simply repetitions to test consistency.

Table 2: Inputs for Free Flow Traffic

Distance for which overlaps are prevented (m)	300
No. of days of traffic required	1
Site flow data to be used	2
Site weight data to be used	2
Vehicle buffer size	1000
No lanes in direction 1	2
No lanes in direction 2	0
Nominal congested spacing, front to back (m)	6
congested speed (km/h)	
Congested gaps coefficient of variation	
Headway model to be used	6
Proportion of cars	0

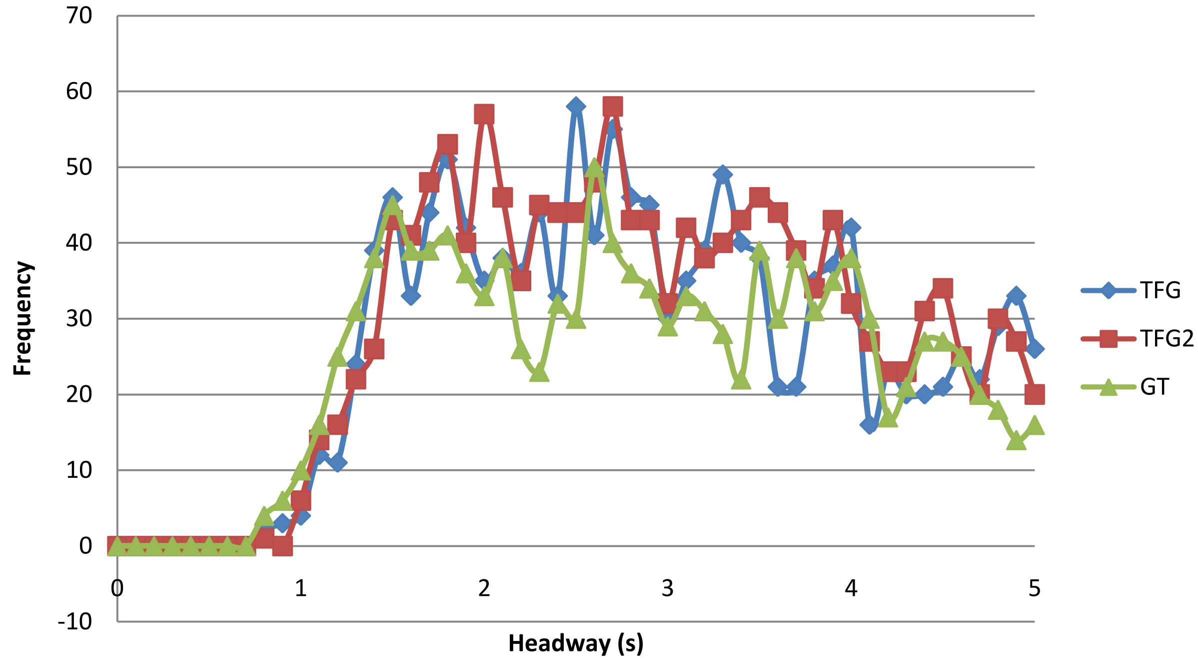

Fig. 5: Free flowing Headway (s)

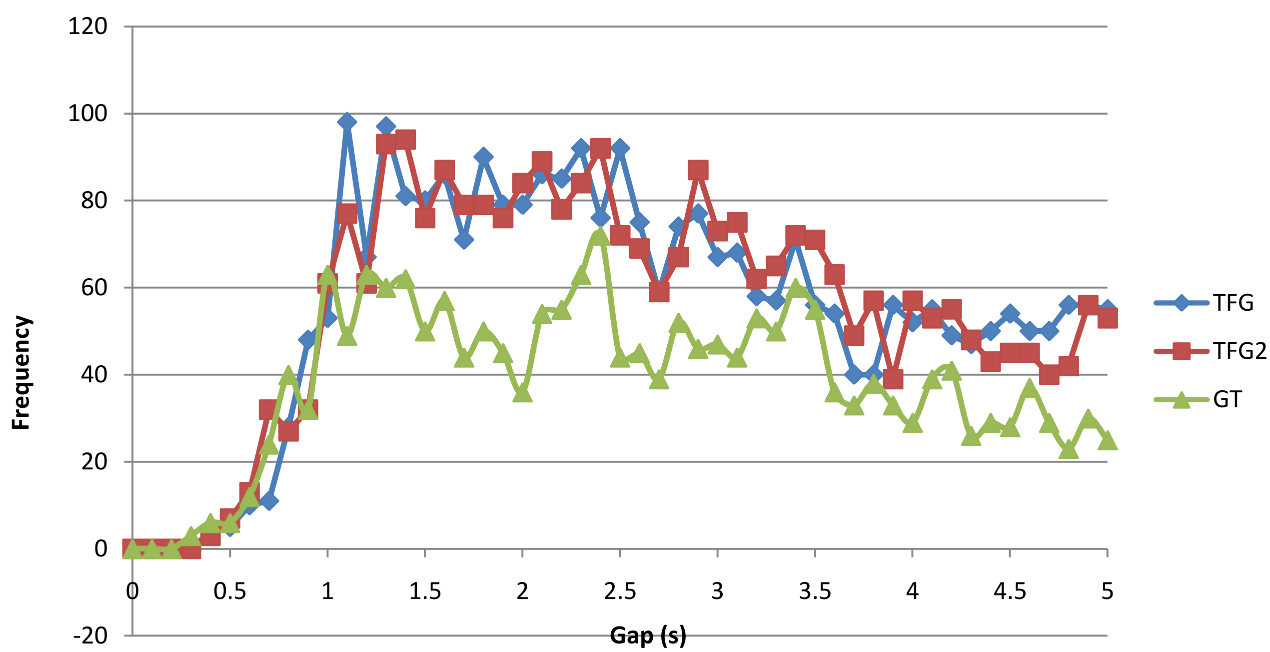

Fig. 6: Free flowing Gap (s)

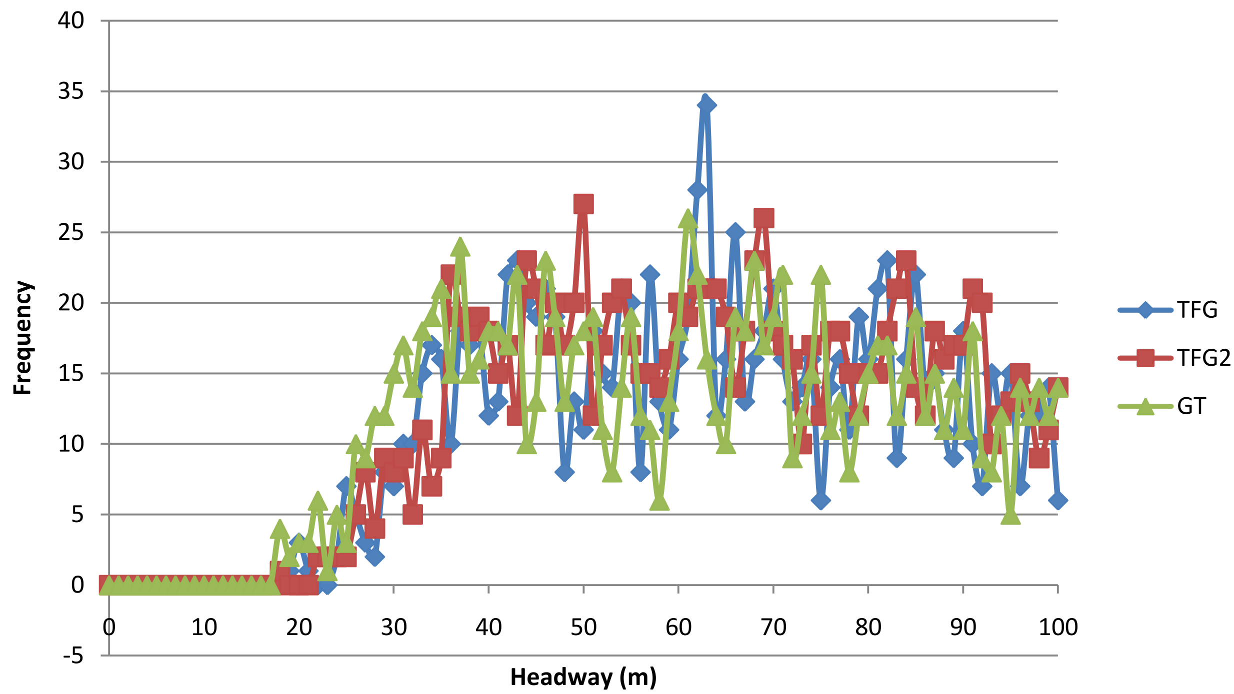

Fig. 7: Free flowing Headway (m)

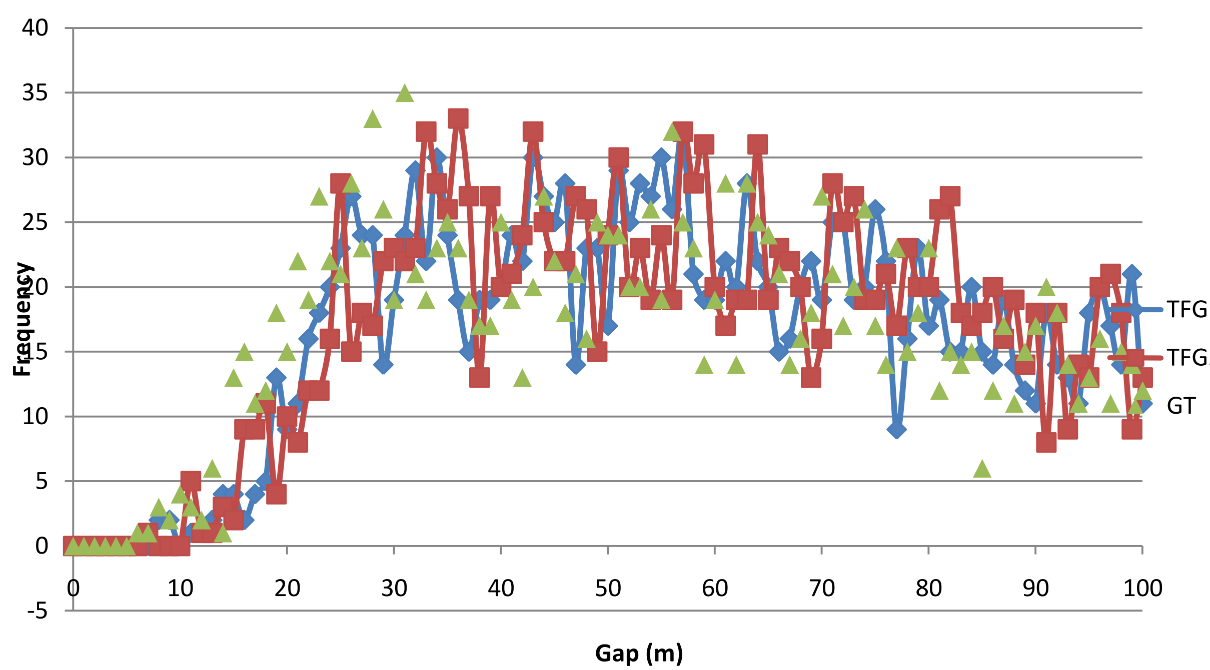

Fig. 8: Free flowing Headway (m)

Study 2: Influence of Cars on Gap & Headway

This study aims to compare gap & headway for files generated using TrafficFlowGenerator with varying percentages of cars.

For this study one day of congested traffic was generated 5 times, each time with a decreasing number of cars (92%, 70%, 50%, 20% and 0% cars). The same inputs were applied to this study as previously described in Table 1. The number of trucks was kept constant each time but the overall number of vehicles varied.

For this study headway is defined as the distance between the front axle of one vehicle and the front axle of the next vehicle and gap is the distant between the rear axle and the front axle of the next vehicle.

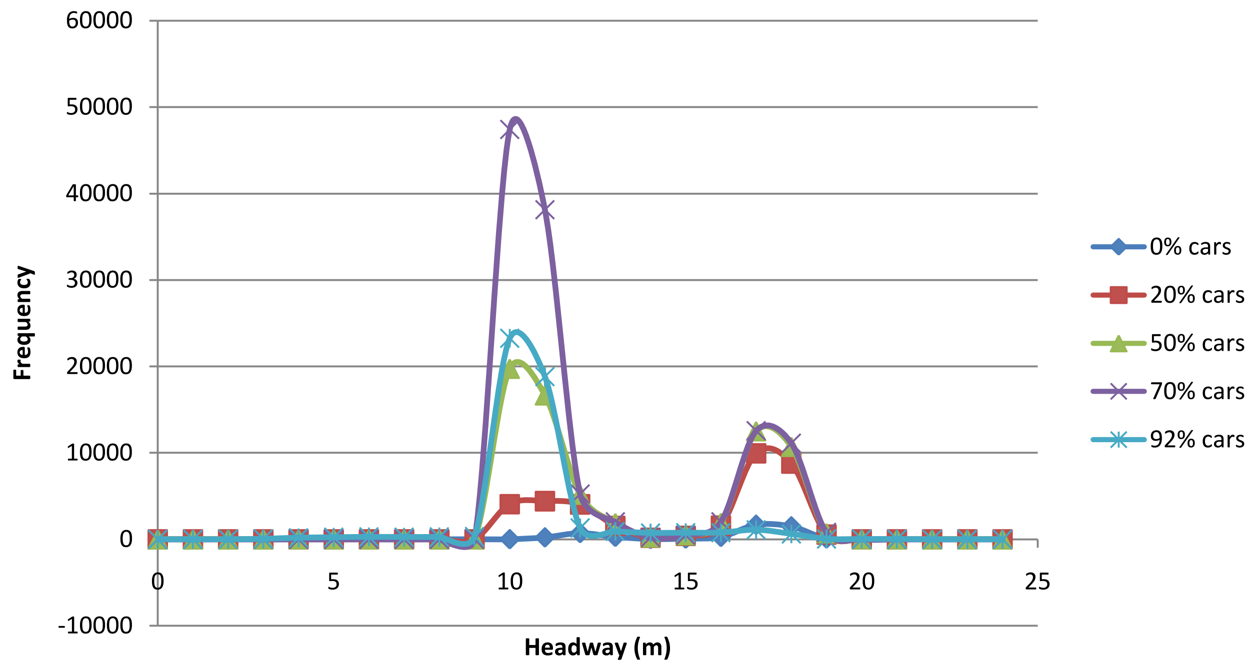

Fig. 9: Headway (m)

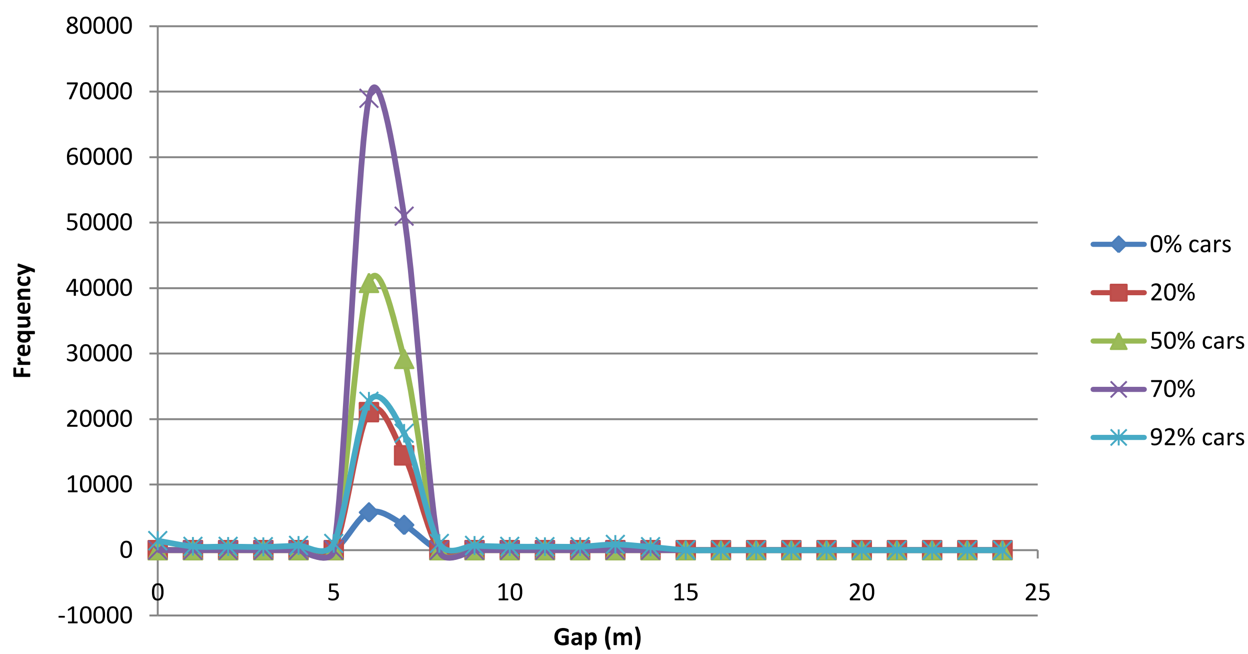

Fig. 10: Gap (m)

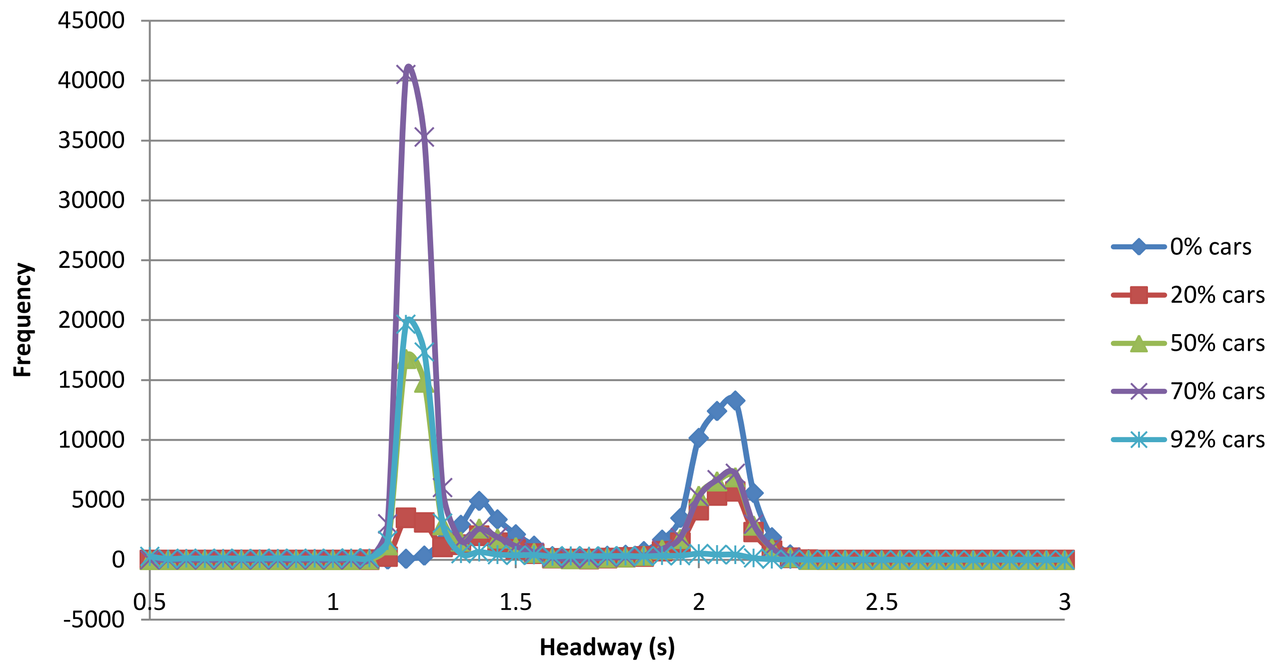

Fig. 11: Headway (s)

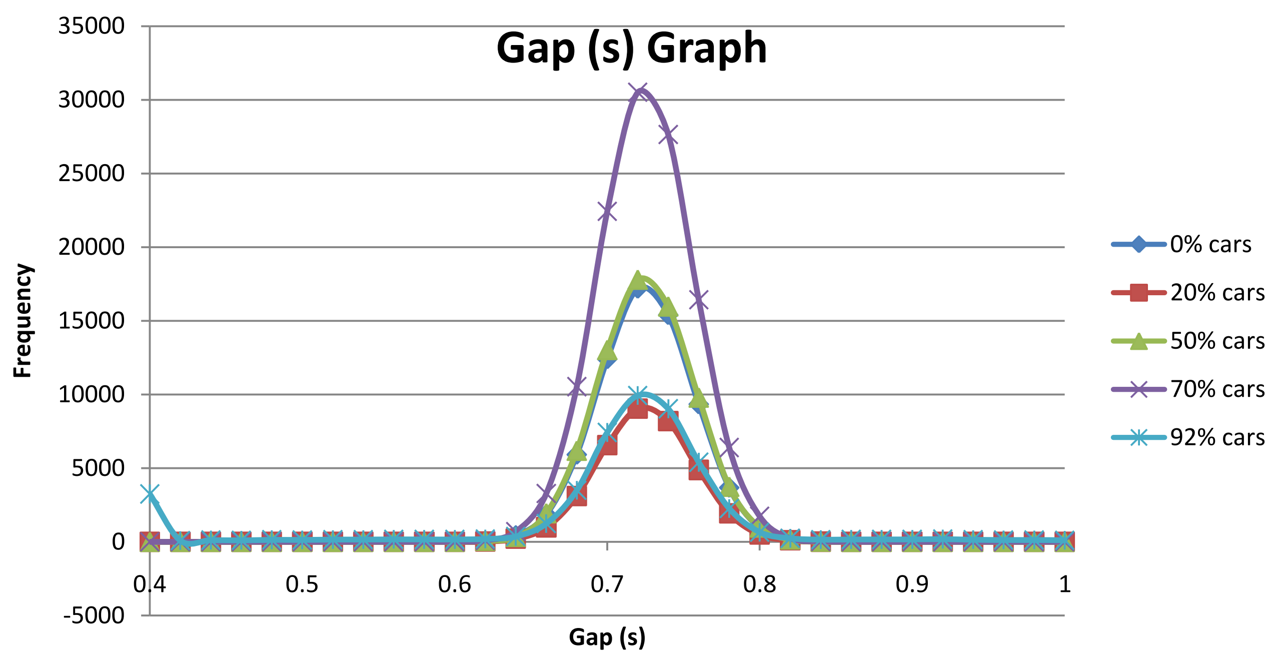

Fig. 12: Gap (s)

Study 3: Driving Analysis

The aim of this study was to find IDM parameter values which give realistic driver behaviour in EvolveTraffic. The distribution was kept constant which meant that only location is important, the scale and shape do not affect the driver behaviour.

IDM Parameter Values:

IDM Parameters for Vehicle Class: Class 0 - Cars | << Copy from <<

	Distribution	Location	Scale	Shape
Safe time headway, T (s)	Constant	1.60	0.05	0.00
Maximum acceleration, a (m/s^2)	Constant	0.70	0.05	0.00
Comfortable decceleration, b (m/s^2)	Constant	1.70	0.10	0.00
Minimum jam distance, s0 (m)	Constant	2.00	0.05	0.00
Elastic jam distance, s1 (m)	Constant	0.00	0.70	0.00
Desired velocity, v0 (km/h)	Constant	120.00	7.00	0.00
Acceleration exponent, delta	Constant	4.00	2.00	0.00
Lane change politeness factor, p	Constant	0.20	2.00	0.00
Outside lane bias factor, deltaAbias	Constant	1.00	2.00	0.00
Lane change threshold, deltaAth (m/s^2)	Constant	0.30	2.00	0.00

Fig. 13: IDM Parameter Values for cars & small trucks

IDM Parameters for Vehicle Class: Class 2 - Large Truck | << Copy from <<

	Distribution	Location	Scale	Shape
Safe time headway, T (s)	Constant	2.00	0.05	0.00
Maximum acceleration, a (m/s^2)	Constant	0.40	0.05	0.00
Comfortable decceleration, b (m/s^2)	Constant	1.20	0.10	0.00
Minimum jam distance, s0 (m)	Constant	4.00	0.05	0.00
Elastic jam distance, s1 (m)	Constant	0.00	0.70	0.00
Desired velocity, v0 (km/h)	Constant	80.00	7.00	0.00
Acceleration exponent, delta	Constant	4.00	2.00	0.00
Lane change politeness factor, p	Constant	0.20	2.00	0.00
Outside lane bias factor, deltaAbias	Constant	1.00	2.00	0.00
Lane change threshold, deltaAth (m/s^2)	Constant	0.30	2.00	0.00

Fig. 14: IDM Parameter Values for large trucks, cranes & low-loaders

Road Configuration:

The road configuration used for EvolveTraffic shown below used the following:

The road was 3km long and had a speed limit of 10kph starting 2.8km along the road.

92% cars was assumed when generating traffic in TrafficFlowGenerator. The inputs for TrafficFlowGenerator are as described in Table 2.

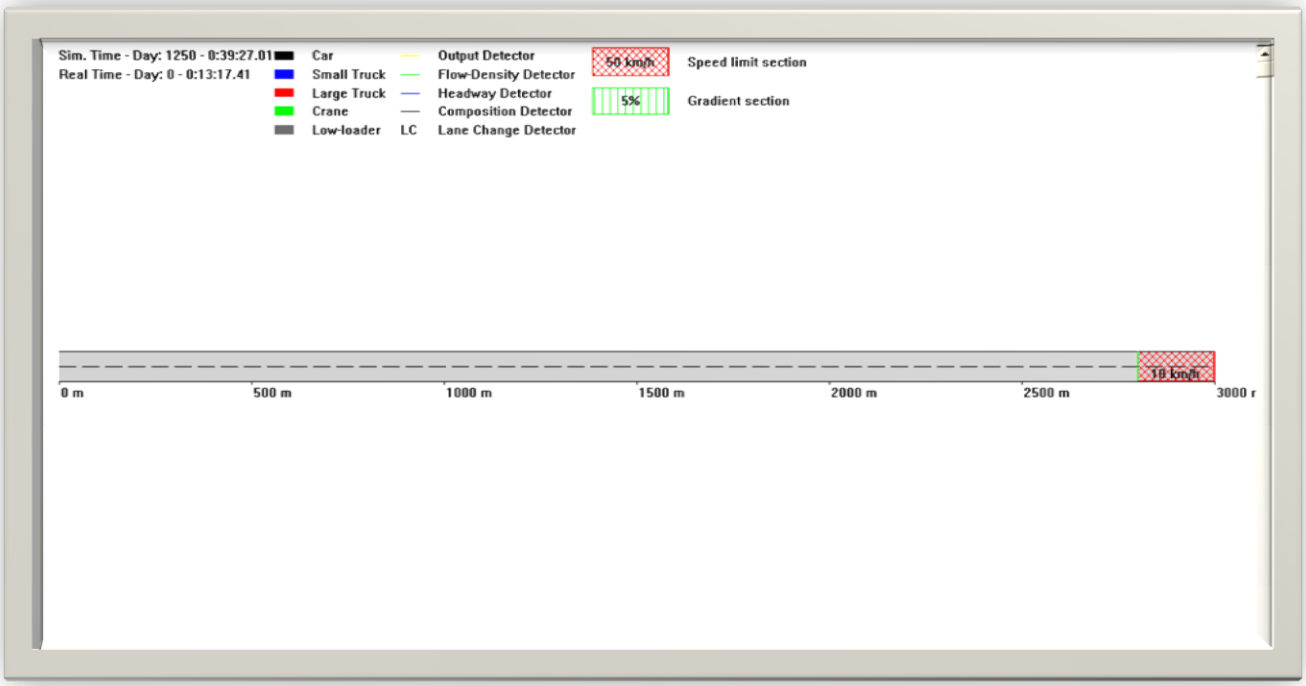

Fig. 15: Road Configuration

Screenshot of Traffic:

A stop go type of congestion is observed for these parameters (accordion effect). A screen shot of this is shown below:

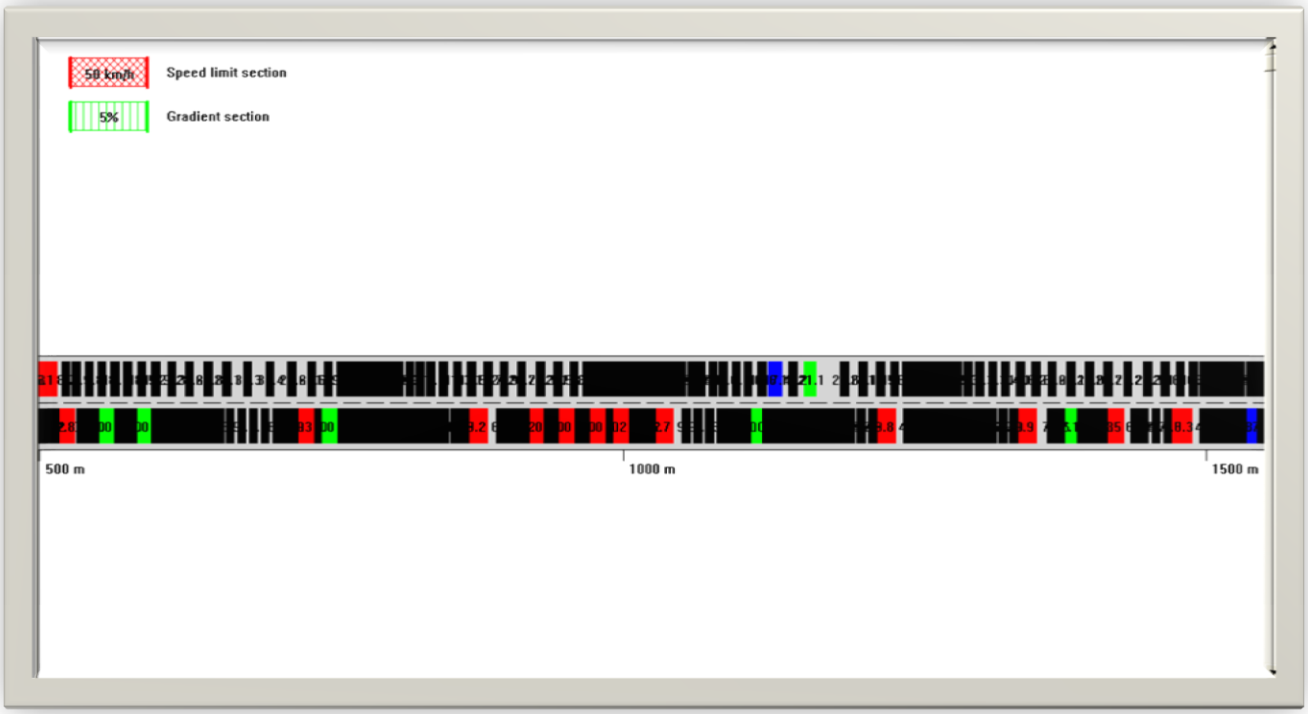

Fig. 15: Screenshot of traffic

Study 4: Convergence Test

This study aims to test how many days of traffic need to be run through EvolveTraffic in order for the traffic pattern to converge.

This test was carried out by generating 3 separate traffic files in TrafficFlowGenerator. The first file contained one day of congested traffic data, the second-2 days and the third-3 days. The same assumptions were made in generating these files as were for the other two studies and the EvolveTraffic parameters and road configuration were used as previously described.

These 3 files were run through EvolveTraffic and the frequency of truck platoons was analysed using Excel. Shown below is the resultant graph comparing Gumbel Reduced Variate and the number of trucks in the platoons for each file before and after the files were run through Evolve. CDF is the proportion of platoons with less than or equal to this number of trucks.

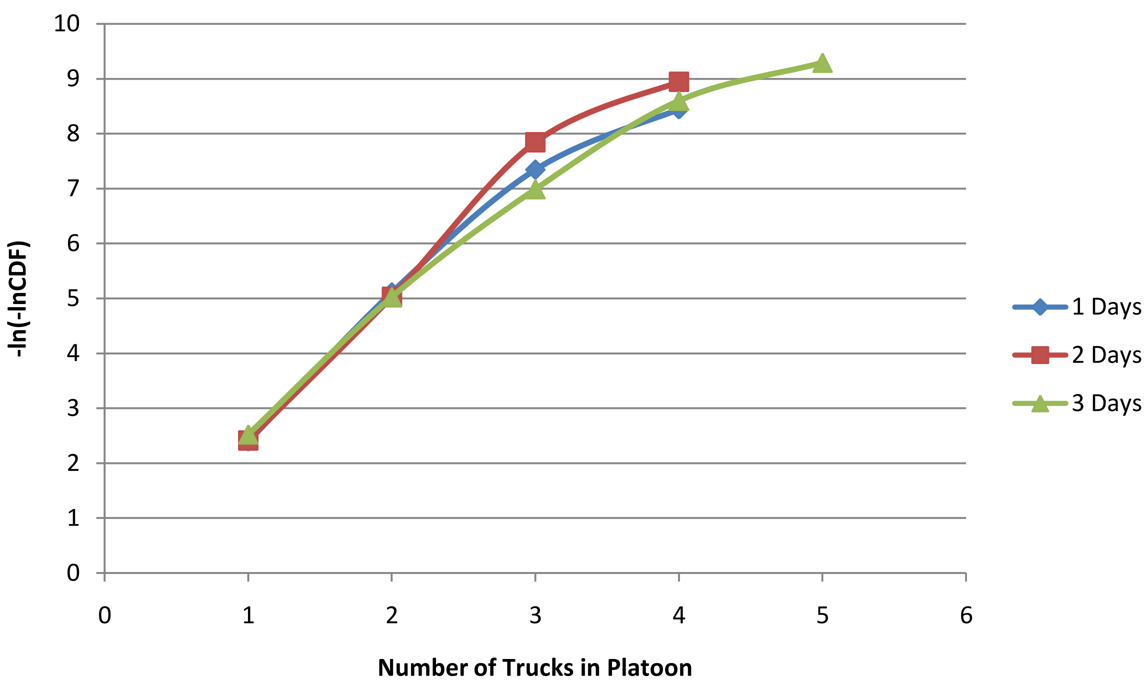

Fig. 16: Before EvolveTraffic

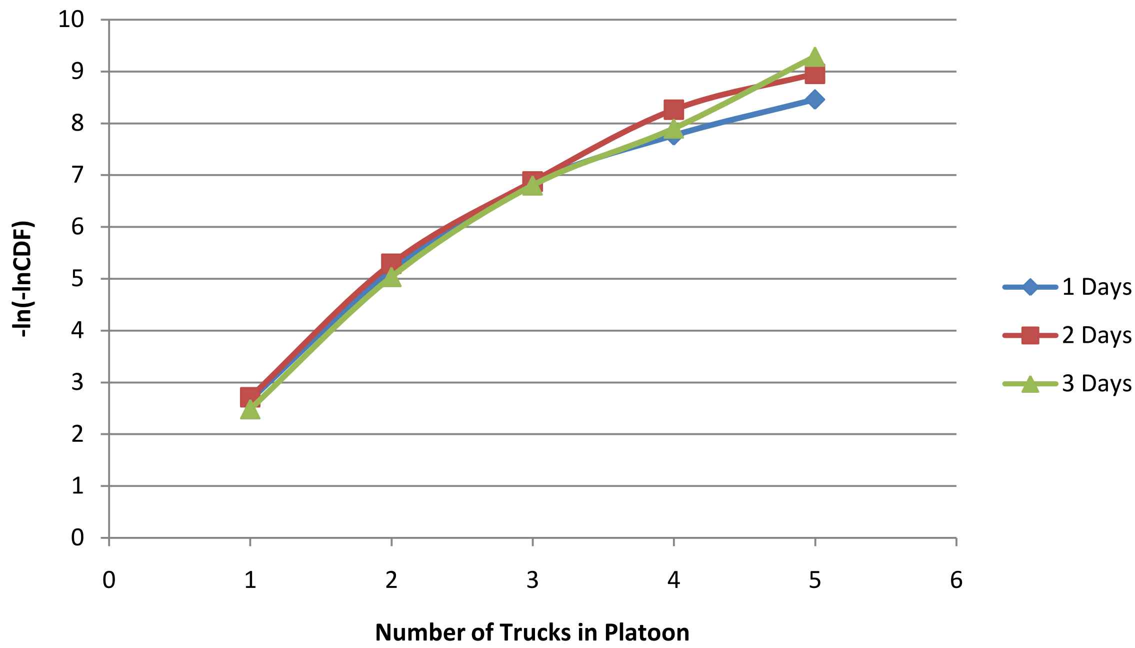

Fig. 17: After EvolveTraffic

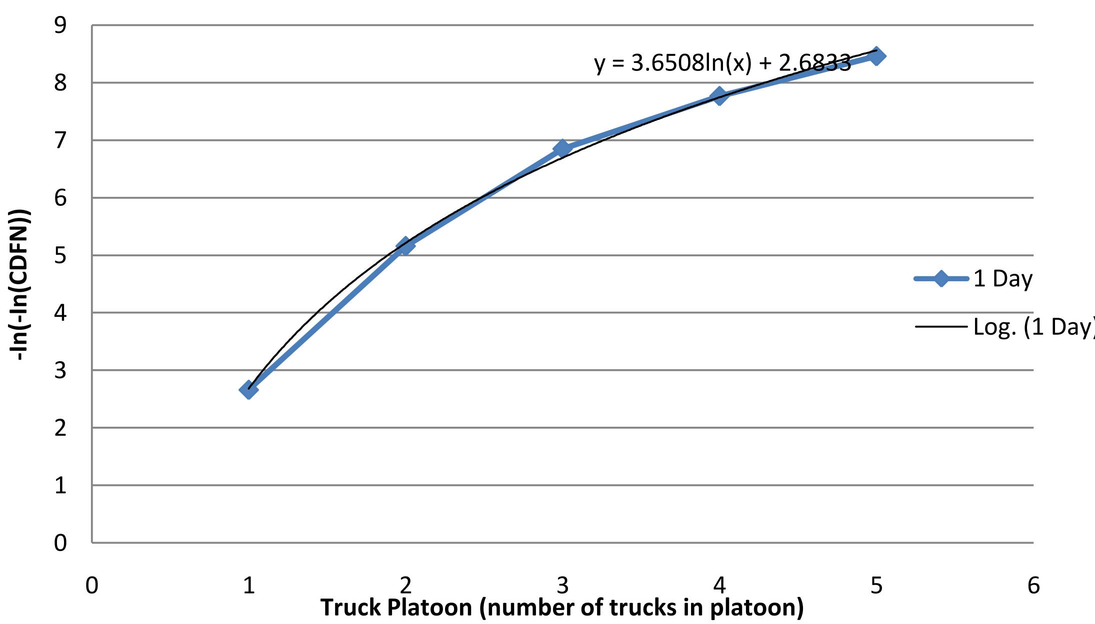

Fig. 18:

Fig. 18: 1 day after EvolveTraffic

A natural log curve is fitted to this graph and its equation is shown to be “3.6508ln(x) + 2.6833”. In order to compare the graphs obtained from 1, 2 & 3 days of data, the slope of the graph is necessary. The above graph can be made to appear linear if a natural log is applied to the values on the x-axis as shown below:

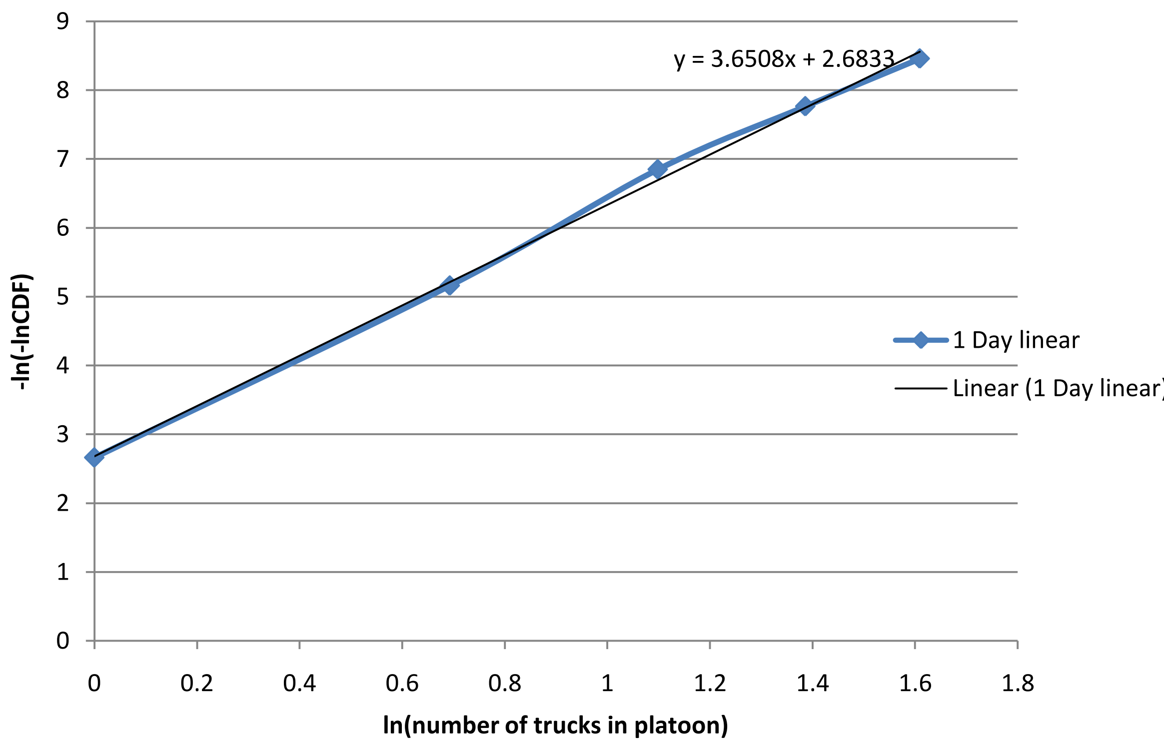

Fig. 19: 1 day after EvolveTraffic (linear)

The slope of this (linear) graph is easily found to be 3.6508 and this piece of information can be used to compare the Gumbel Reduced Variate graphs, refer to Colin Caprani’s PhD thesis 2005 for more information.

The graph shown below is of the slope of each of the Gumbel Reduced Variate graphs (1, 2 & 3 days of traffic-after EvolveTraffic) against the number of days it took for this slope to be obtained.

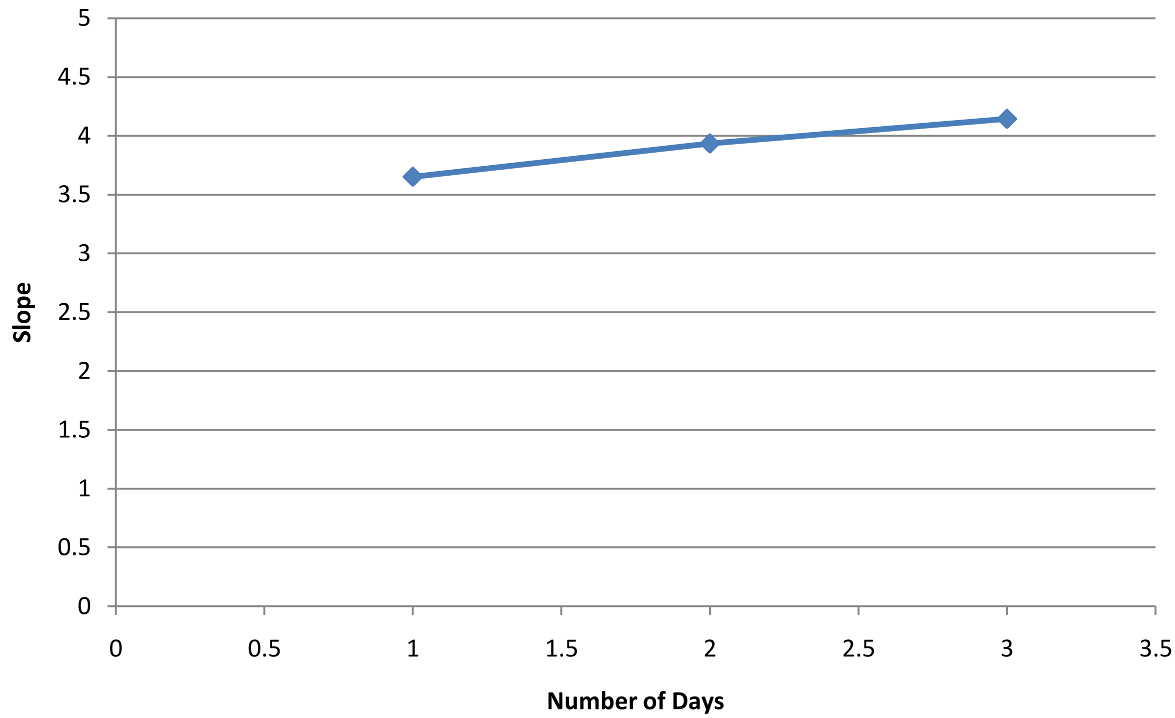

Fig. 20: Convergence Test

Study 5: Sensitivity Study

For this study one day of free flowing traffic with 92% cars was generated using TrafficFlowGenerator. The same assumptions were used for this study as previously described. This file was used as the input to EvolveTraffic for each run. The same road configuration was used in Evolve Traffic as previously described.

There are ten IDM parameters in EvolveTraffic and for this study eight of these were varied individually while keeping the rest constant. An initial run where all parameters were at an initial base value, these values are described above, was made and the output analysed. Graphs similar the graphs in the previous study were drawn and their slopes (found as previously described) were used to compare the output data.

The parameters which were varied are as follows:

-Safe Time Headway, T (s)

-Maximum Acceleration, a (m/s^2)

-Comfortable Decceleration, b (m/s^2)

-Minimum Jam Distance, s0 (m)

-Elastic Jam Distance, s1 (m)

-Desired Velocity, v0 (km/h)

-Lane Change Politeness Factor, p

-Outside Lane Bias Factor, deltaAbias

-Lane Change Threshold, deltaAth (m/s^2)

The slope obtained when all parameters were at their initial base value was **4.21**.

The following table shows the values of the parameters in each case and the slope obtained from each set of values.

Table 3: Data obtained in Study 5

Parameter		**Half**	**Actual**	***1.25**	**Double**
Safe Time Headway, T(s)	**Value (cars):**	0.8	1.6	2	3.2
	Value (Trucks):	1	2	2.5	4
	Slope:	4.31	4.21	4.517	4.439
Maximum Acceleration, a (m/s^2)	**Value (cars):**	0.35	0.7	0.88	1.4
	Value (Trucks):	0.2	0.4	0.5	0.8
	Slope:	5.13	4.21	4.4426	0.4432
Comfortable Deceleration, b (m/s^2)	**Value (cars):**	0.85	1.7	2.1	3.4
	Value (Trucks):	0.6	1.2	1.5	2.4
	Slope:	3.2878	4.21	5.046	5.02
Minimum Jam Distance, s0 (m)	**Value (cars):**	1	2	2.5	4
	Value (Trucks):	2	4	5	8
	Slope:	3.9	4.21	4.099	4.199
Elastic Jam Distance, s1 (m)	**Value (cars):**		0	10	20
	Value (Trucks):		0	10	20
	Slope:		4.21	3.882	4.44
Desired Velocity, v0 (km/h)	**Value (cars):**	60	120	150	240
	Value (Trucks):	40	80	100	160
	Slope:	4.119	4.21	4.3399	5.042
Lane Change Politeness Factor, p	**Value (cars):**	0.1	0.2	0.25	0.4
	Value (Trucks):	0.1	0.2	0.25	0.4
	Slope:	4.294	4.21	4.355	3.622
Outside Lane Bias Factor, deltaAbias	**Value (cars):**	0.5	1	1.25	2
	Value (Trucks):	0.5	1	1.25	2
	Slope:	5.0496	4.21	5.095	5.089
Lane Change Threshold, deltaAth (m/s^2)	**Value (cars):**	0.15	0.3	0.4	0.6
	Value (Trucks):	0.15	0.3	0.4	0.6
	Slope:	3.608	4.21	4.1707	3.586

The files containing all output files from EvolveTraffic, the metrics files from EvolveTraffic and the individual Excel files used to extract the above data can be found in “Sensitivity Study/Varying Parameters”. The file containing this information for the base values run is “Sensitivity Study/Average Values”.

The following are a set of graphs, one for each parameter, showing how the slope obtained at each value of parameter varies.

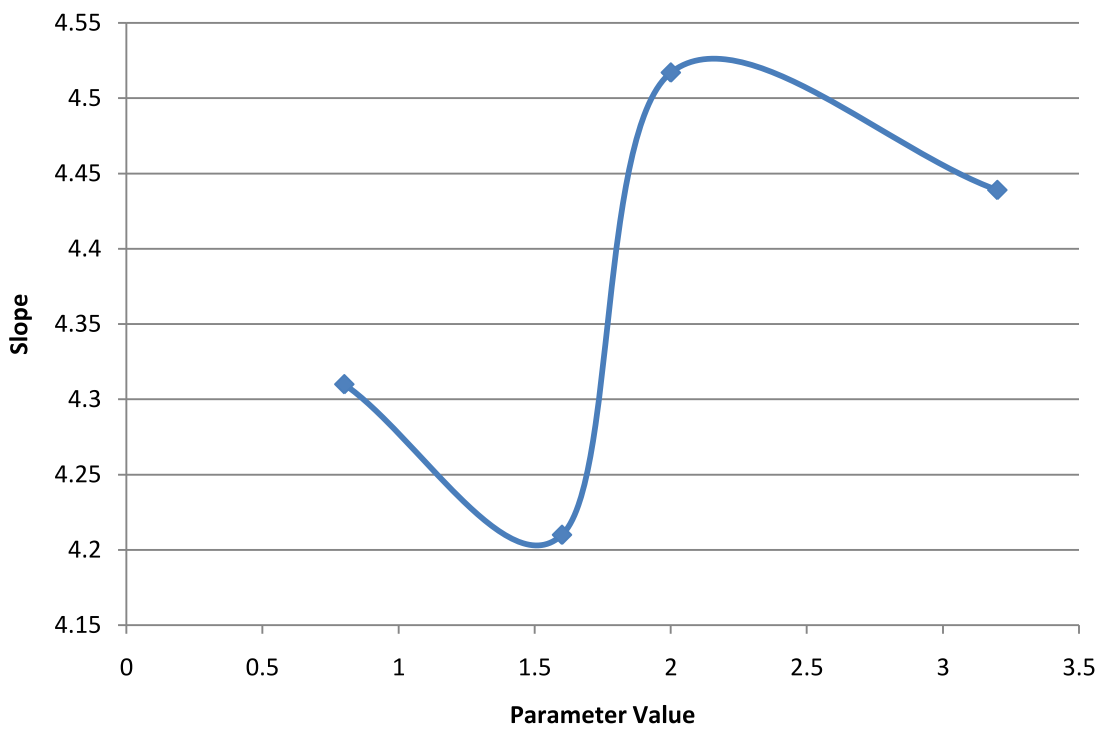

Fig. 21: Safe Time Headway, T (s)

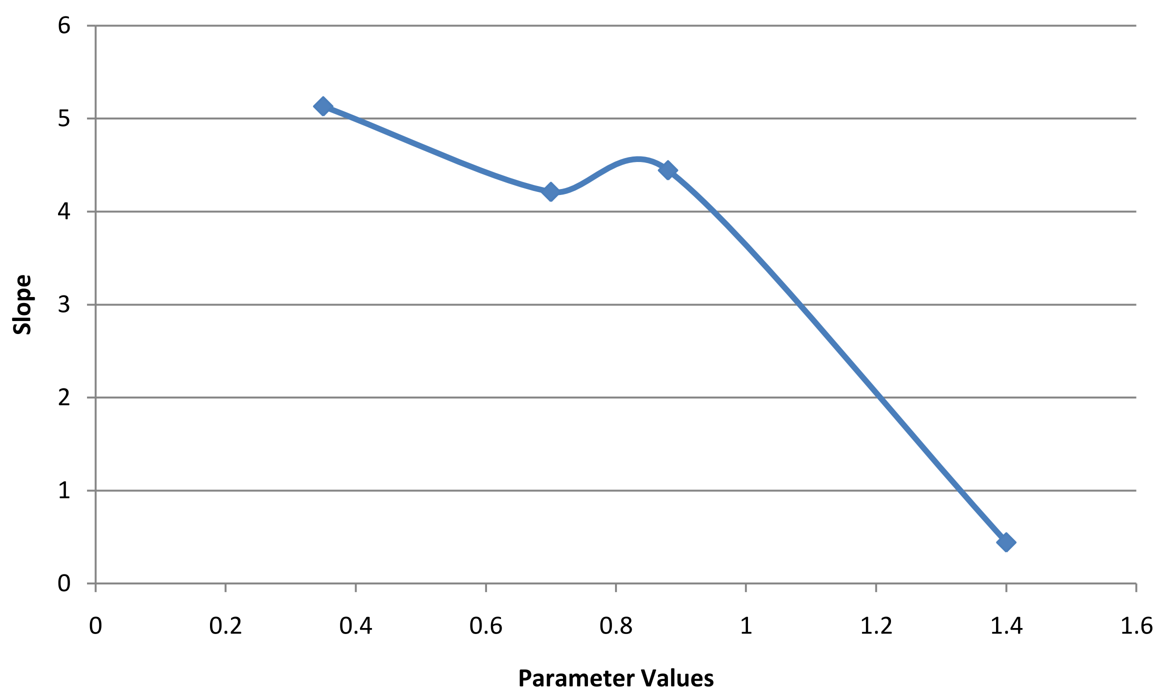

Fig. 22: Maximum Acceleration, a (m/s^2)

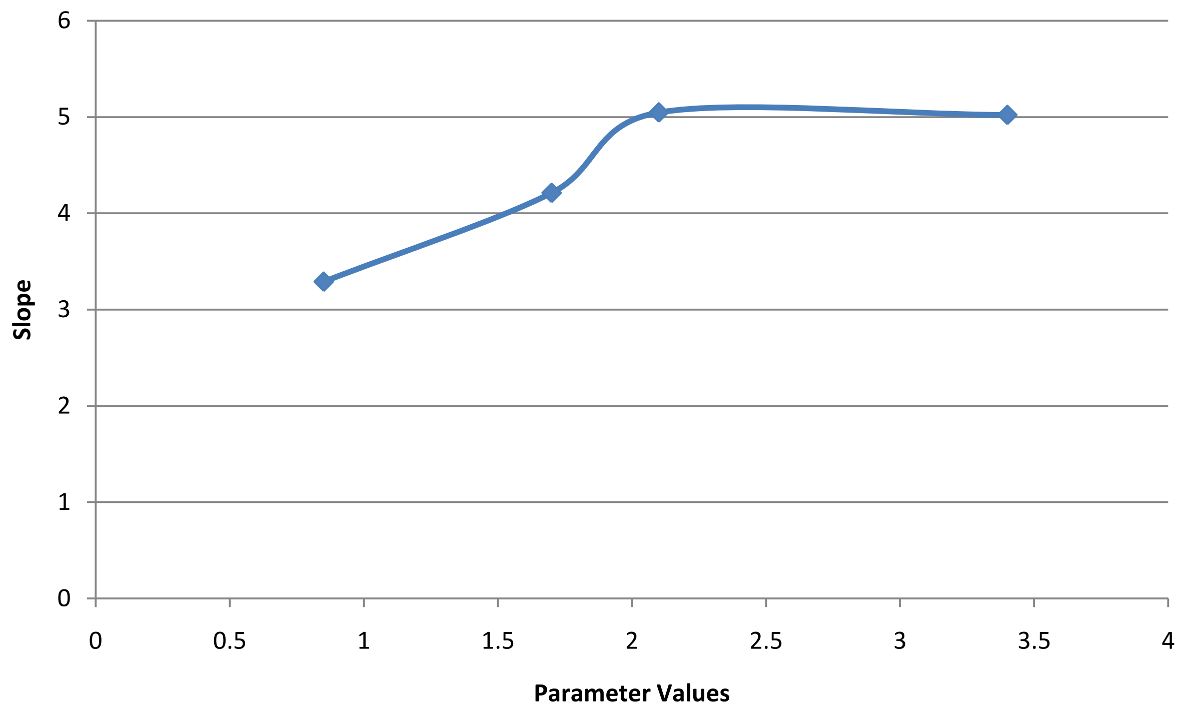

Fig. 23: Comfortable Deceleration, b (m/s^2)

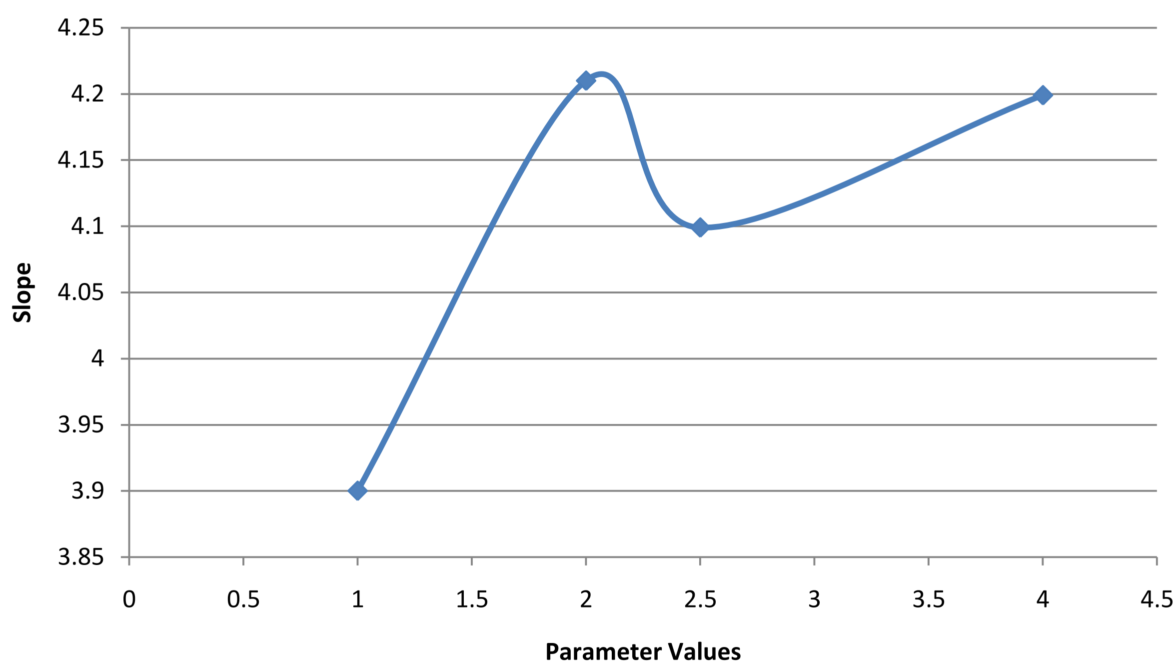

Fig. 24: Minimum Jam Distance, s0 (m)

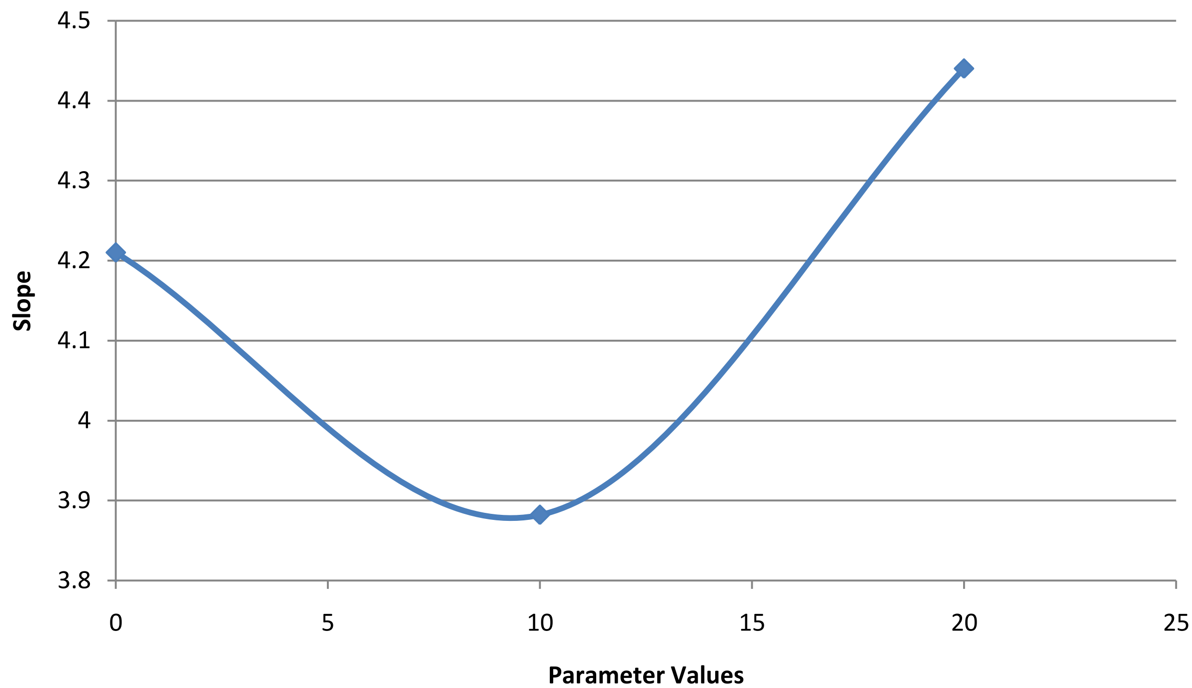

Fig. 25: Elastic Jam Distance, s1 (m)

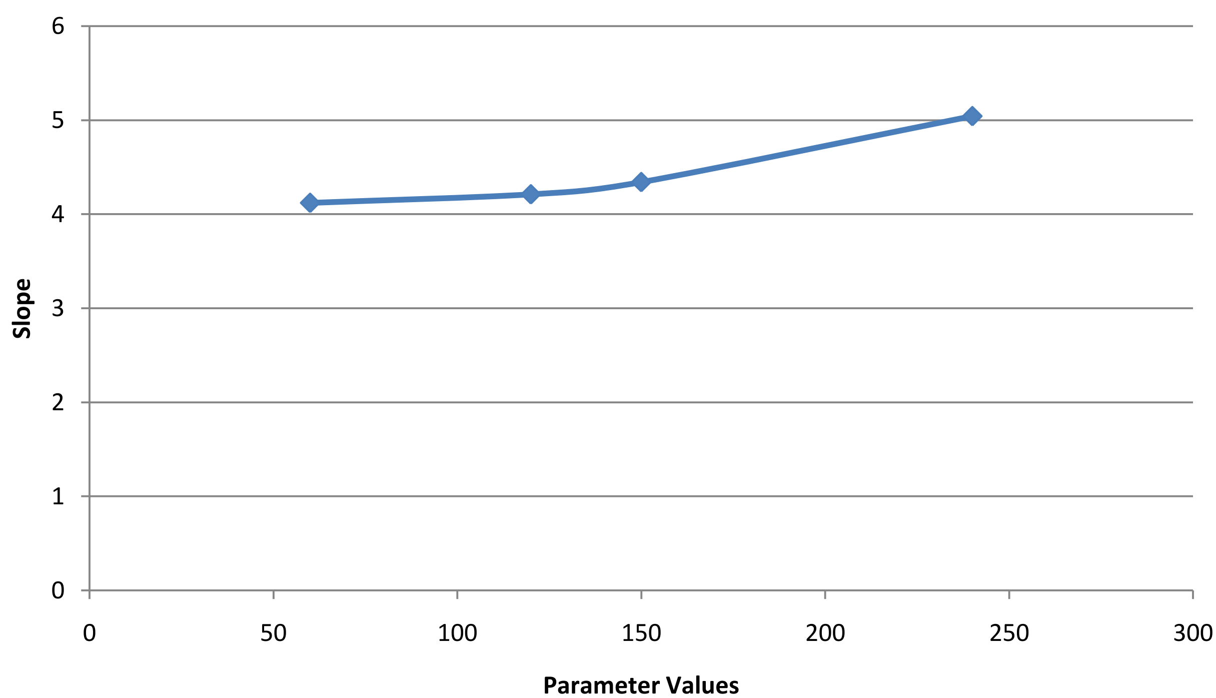

Fig. 26: Desired Velocity, v0 (km/h)

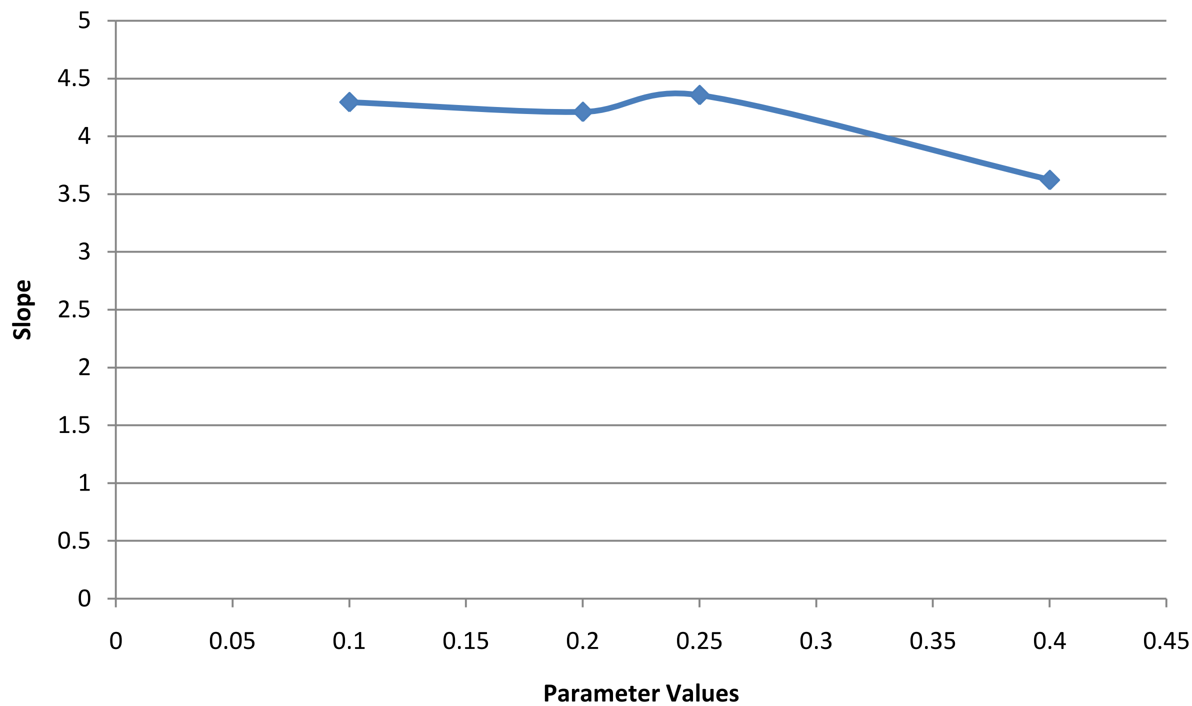

Fig. 27: Lane Change Politeness Factor, p

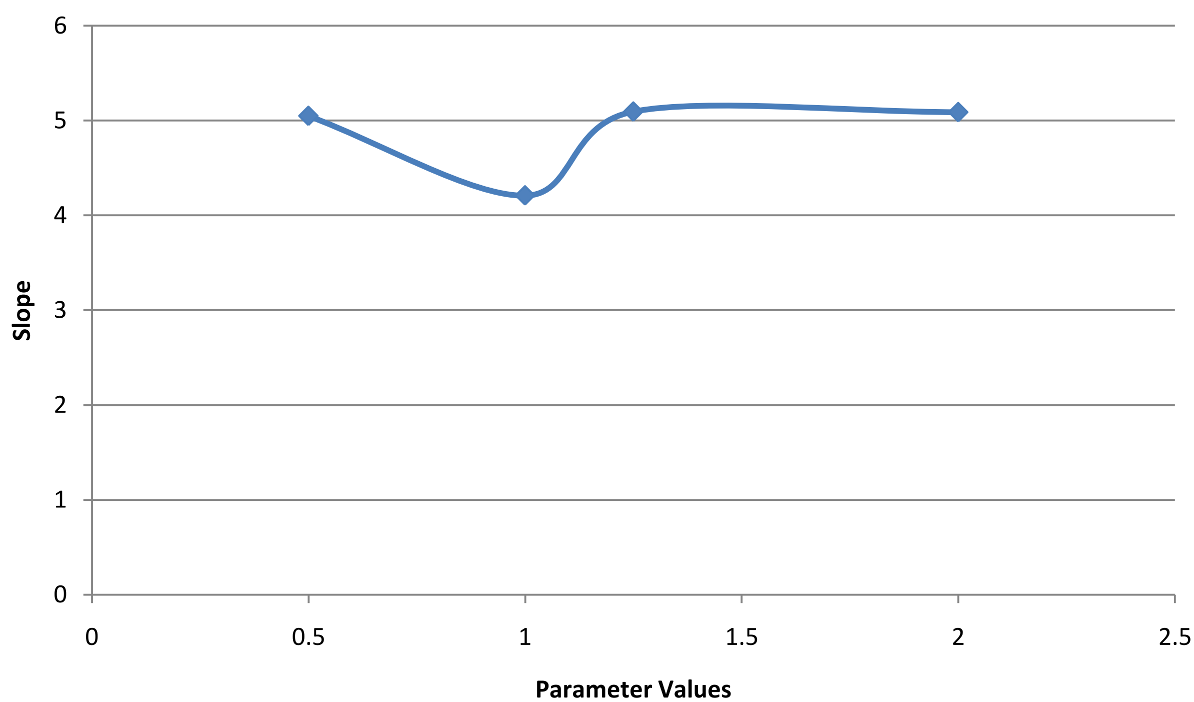

Fig. 28: Outside Lane Bias Factor, deltaAbias

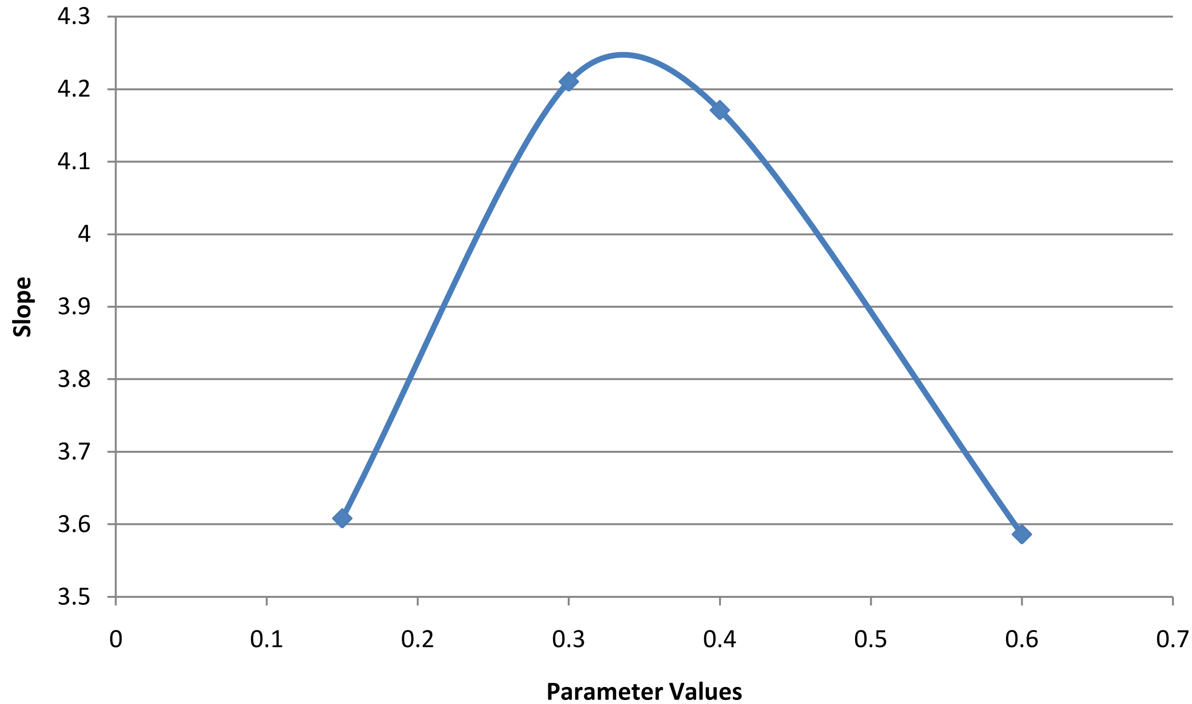

Fig. 29: Lane Change Threshold, deltaAth (m/s^2)

For the above graphs a lower slope indicates a greater frequency of truck platoons with a great number of trucks (i.e. 3, 4 trucks in a platoon)

Therefore it can be observed that the following parameters most affect the frequency of these truck platoons:

-Safe Time Headway, T (s)

- Maximum Acceleration, a (m/s^2)

- Minimum Jam Distance, s0 (m)

- Elastic Jam Distance, s1 (m)

- Lane Change Threshold, deltaAth (m/s^2)