Development of Intersection Traffic Accident Risk Assessment Model

- Application of Micro-simulation Model with SSAM to Sungnam City -

SESSION 6

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1. Introduction

Background of the "Traffic Safety Master Plan" for Sungnam

- Korean recorded 4th highest traffic accident toll among 29 OECD countries in 2007.
- Korean Government (The Ministry of Land, Transport and Maritime Affairs) amended the Traffic Safety Law in 2008

  => more responsibility to Local Authority

- The law requires local government to prepare "Traffic Safety Master Plan" for every 5 years.
- KOTI (Korea Transport Institute) & TERI conducted "Traffic Safety Master Plan" for Sungnam as a part of 5-year traffic safety research and development project" sponsored by the central government.

2. Main Theme of the Paper

- SSAM (Surrogate Safety Assessment Model, developed by FHWA, US) is applied to a real site in Sungnam, Korea with VISSIM Microsimulation Program.
- SSAM results are produced and discussed for the change of speed limit form 70kph to 60kph
- The nature of using SSAM+Microsimulation for safety assessment is discussed

3. Review of Traffic Accident Risk Assessment Approach

- Traffic accidents at intersections in urban area are the most common and take a majority of the accident toll.

- Without knowing the safety implications of the counter measures, the task normally concentrates on tackling accidents reflected in historic accident data.

- More practical and site specific traffic accident risk assessment methodology is needed.

• Traffic Conflict Analysis (Ho 2004)

The traffic conflict is a measure of road user risk, taking into account driver behaviour, roadway condition and the traffic environment at the moment of exposure.

The severity and nature of traffic conflicts enables qualitative analysis and diagnose inappropriate traffic control, geometric design at intersections and road user behaviour.

Where traffic accident records are not readily available, traffic conflict analysis provide very valuable information and quantifiable safety measures for safety evaluation purposes.

There are notable limitations:

1) traffic conflicts are a record of successful evasive actions, which are not a substitute for good quality collision information.

2) the technique is limited primarily to intersections.

3) the cost for conducting traffic safety studies using the traffic conflict technique could be quite costly,

4) the approach does not provide effectiveness evaluation of planned remedial measures.

• Accident Prediction Model (APM)

TRL developed generalized linear regression model to relate accident frequency by category to functions of traffic and pedestrian flow, and a range of other junction variables.

The model of four- arm junctions was developed on the basis of empirical data collected for 4 years (1979~1982) for 177 four-arm, single carriageway, signalized junctions on 30 mph limit roads in urban areas of UK

Three-arm accident prediction model was developed on the basis of TRL 135(Tylor, Hall and Chatterjee 1996) which studied 6 years (1985-1990) accident data for 221 three-arm junctions in urban areas .

The model requires Traffic flow and Link Length data as minimum. To improve their accident forecasts, the user can input increasing levels of data for geometric data, including junction curvature, sighting distance, entry width.

The typical form of generalized linear model is as follows:

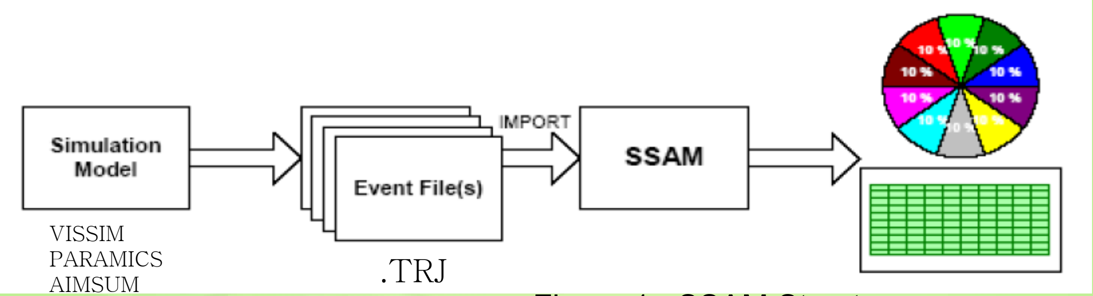
$$\log A = \log b_0 \, x^{b_1} \, x^{b_2} = \log b_0 + b_1 \log x_1 + b_2 \log x_2$$

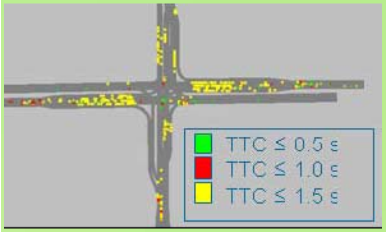
where
A= annual mean number of accidents
x_n = the average daily flow of vehicles,
b_n = the model coefficients

The advantage of APM is that it can be readily applied to four-arm and three-arm intersections in urban areas with minimum data.

The one of the weak point of the APM is that the model is not transferable to other countries because it relies on the UK data. The model implicitly reflects road users' behavior which varies by areas.

• Micro-simulation based Method (SSAM)





<Figure 1> SSAM Structure

SSAM features

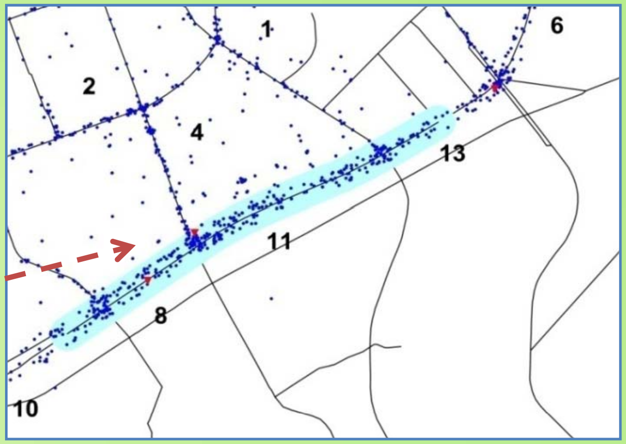
- A table of all conflicts identified in the batch of analyzed TRJ files, including file, time, location, vehicles identifications, and several measures of conflict severity.
- A summary of conflict counts by type and file, with average values of surrogate measures.
- A filtering mechanism that allows the isolation of subsets of conflicts by ranges of surrogate safety measures, conflict type, network link, or a rectangular region of the network.
- A facility for statistical comparisons of the conflict frequencies and values of surrogate safety measures for two alternative cases or designs using the Student t distribution for hypothesis testing.
- A display of the location of conflicts on the network map, with icons of different shapes and colors assignable to different conflict types or severities.

SSAM surrogate safety measures

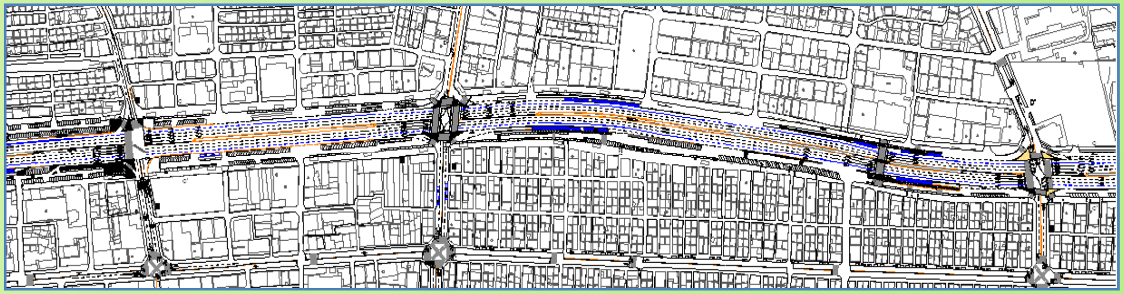
- Minimum time-to-collision (TTC).
- Minimum post-encroachment (PET).
- Initial deceleration rate (DR).
- Maximum deceleration rate (MaxD)
- Maximum speed (MaxS)
- Maximum speed differential (DeltaS).
- Classification as lane-change, rear-end, or path-crossing event type.
- Vehicle velocity change had the event proceeded to a crash (DeltaV)

4. Application of SSAM to Sungnam City

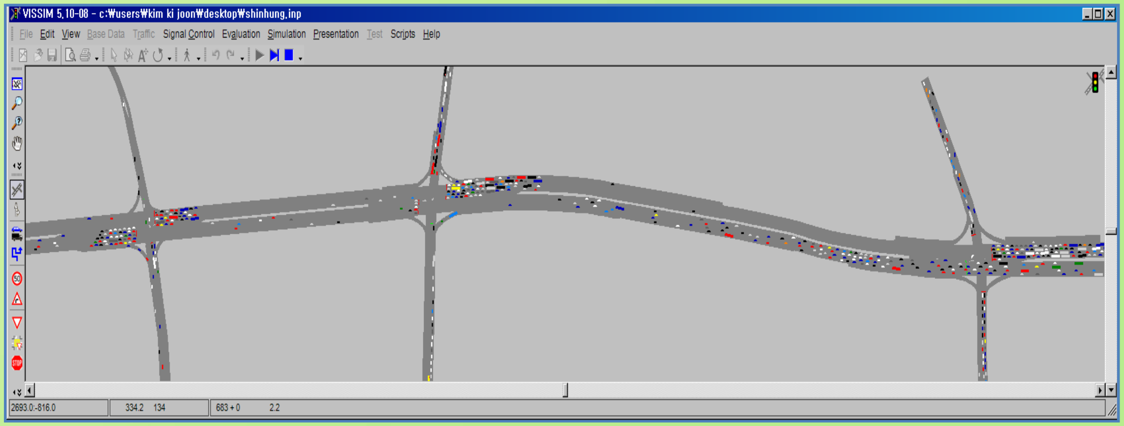
<Figure 2> Location



<Figure 3> Accident Record (2006~2008)



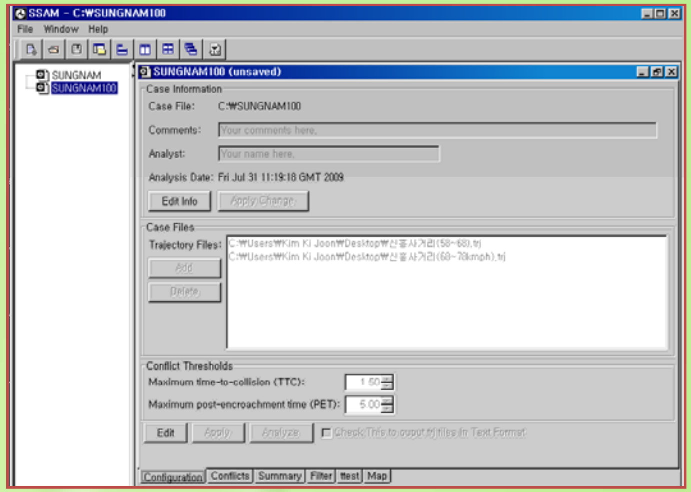
<Figure 4> Test Site

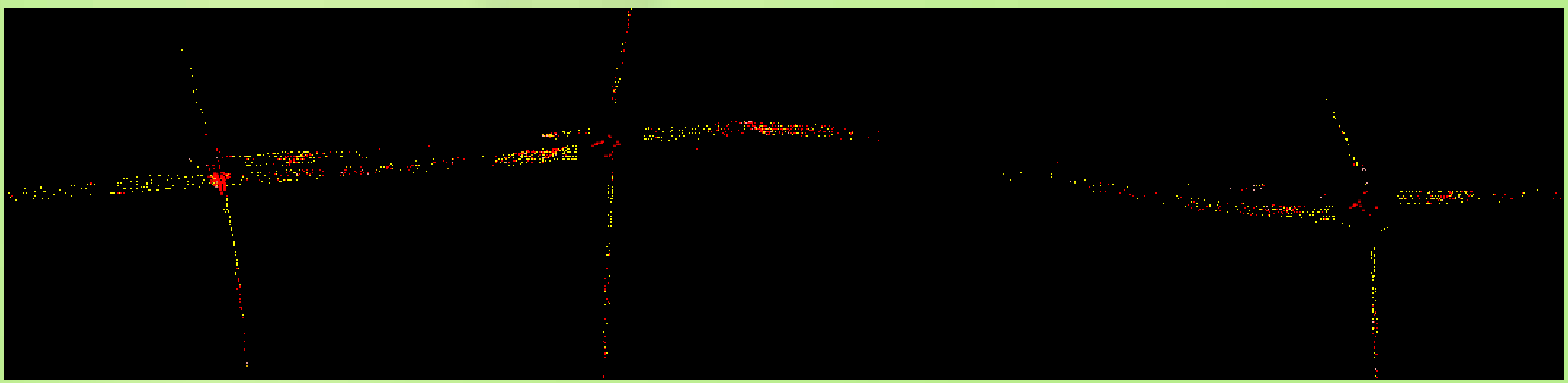


<Figure 5> Test Site VISSIM

• SSAM Program

<Figure 5>
SSAM Program



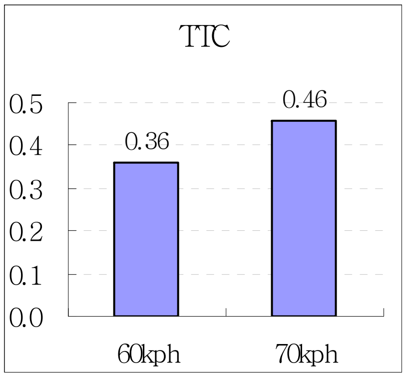


<Figure 5> SSAM Conflict Result :
Graphical

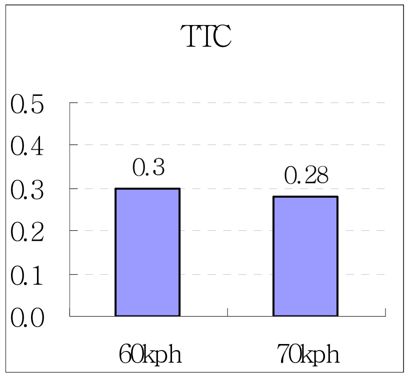
Surrogate Measures Computed by SSAM : Speed Limit 60kph, 70kph cases

TTC : the minimum time-to-collision value observed during the conflict.

Non-Peak

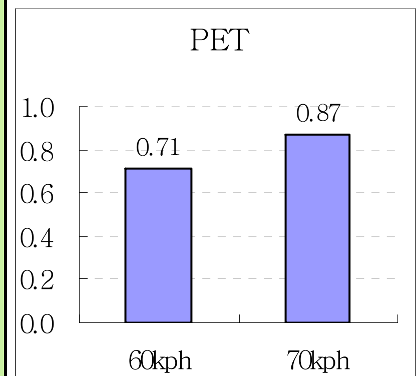


Peak



PET : the minimum post-encroachment time observed during the conflict.

Non-Peak



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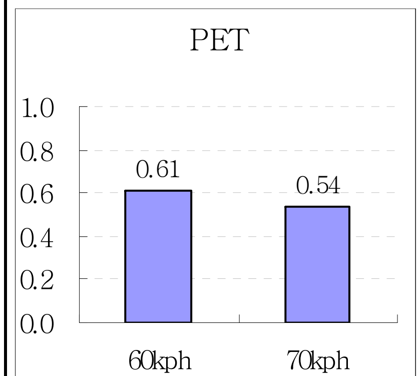
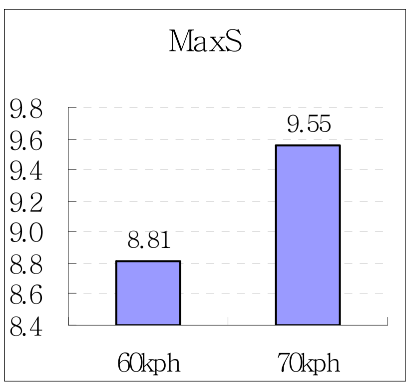
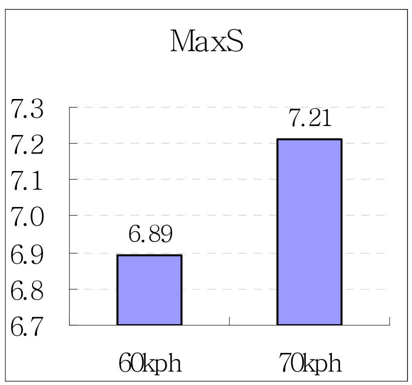


MaxS : the maximum speed of either vehicle throughout the conflict.

Non-Peak

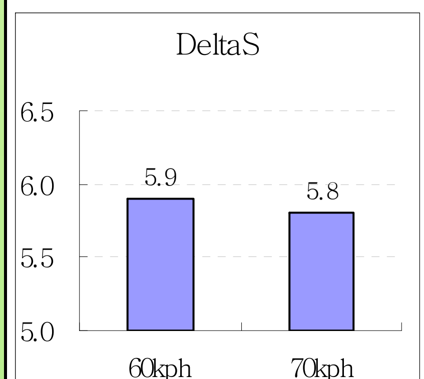


Peak

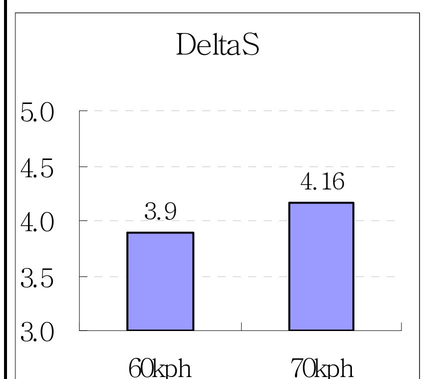


DeltaS : the difference in vehicle speeds as observed at **tMinTTC**.

Non-Peak

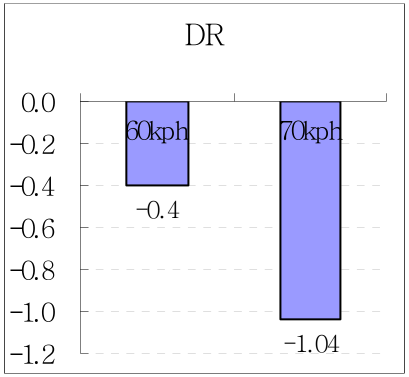
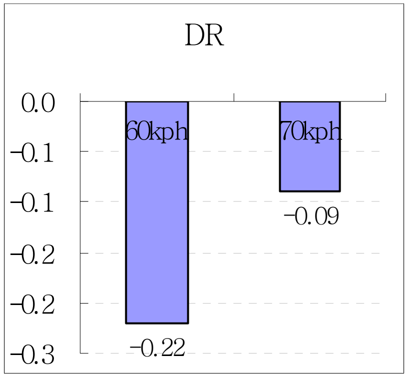


Peak

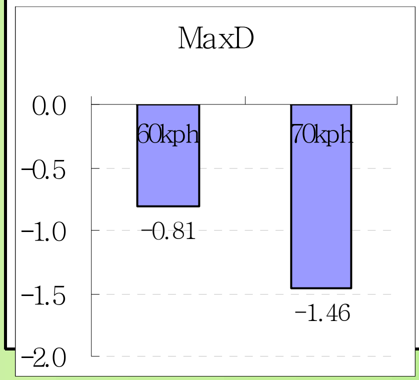
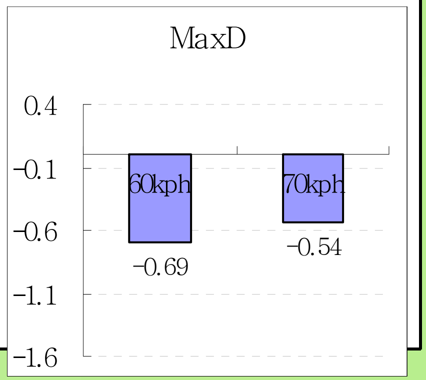


Surrogate Measures Computed by SSAM : Speed Limit 60kph, 70kph cases

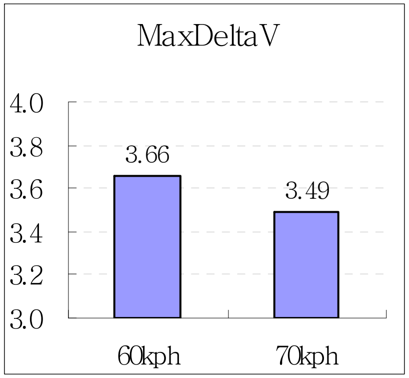
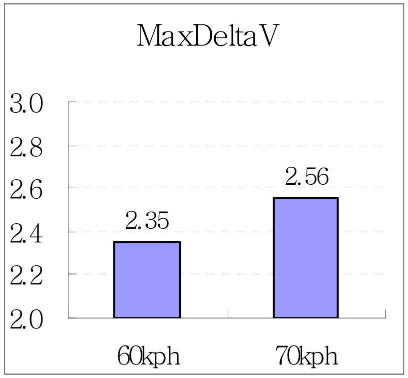
DR : the initial deceleration rate of the second vehicle.

Non-Peak	Peak
	

MaxD : the maximum deceleration of the second vehicle.

Non-Peak	Peak
	

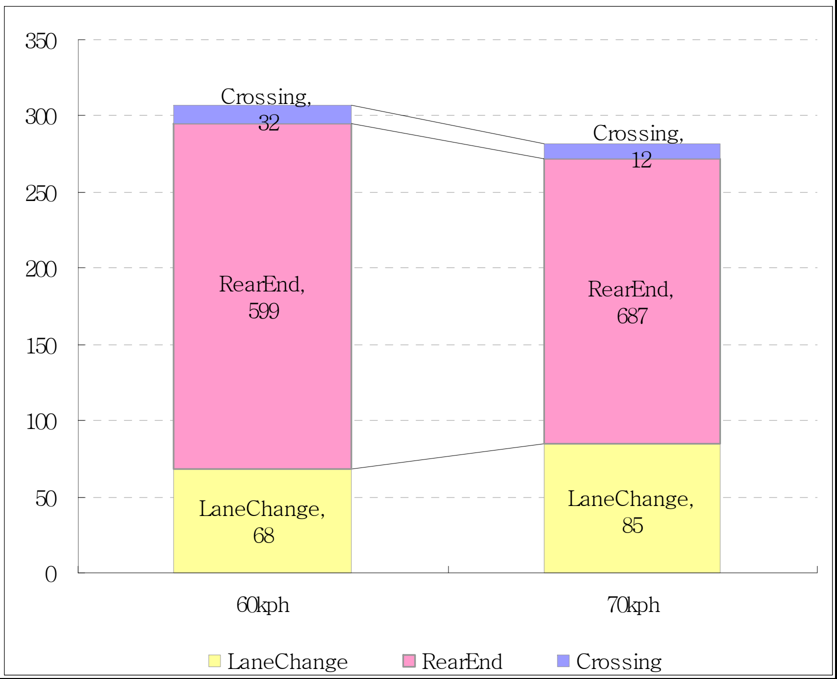
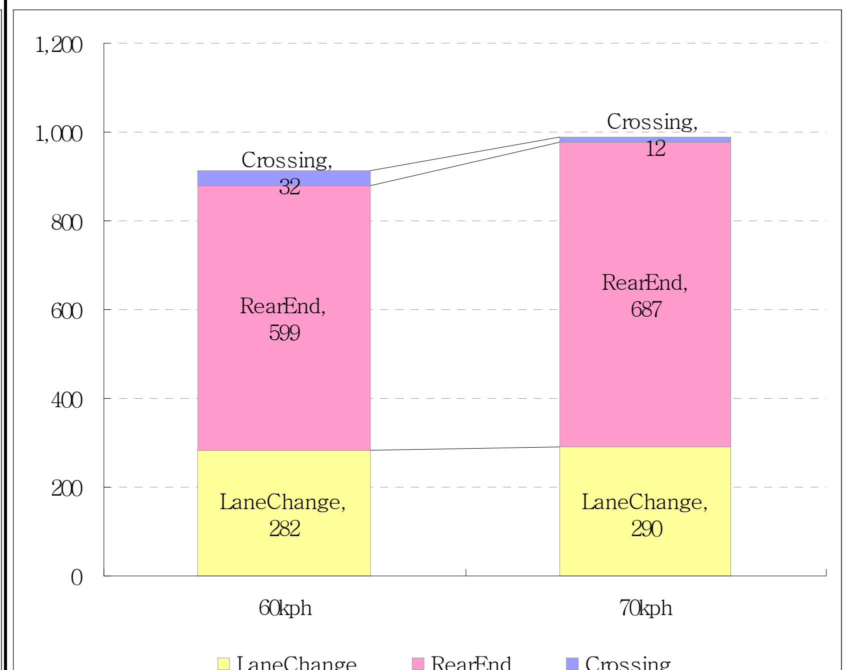
MaxDeltaV : the maximum **DeltaV** value of either vehicle in the conflict.

Non-Peak	Peak
	

Surrogate Measures Computed by SSAM : Speed Limit 60kph, 70kph cases

ConflictType

rear-end conflict if ||**ConflictAngle**|| < 30 °,
a crossing conflict if ||**ConflictAngle**|| > 85 °,
otherwise a lane-changing conflict.

Non-Peak	Peak
	

5. Findings

Positive View

SSAM provides a compelling new option to assess the safety of traffic facilities using popular micro-simulation software.

This approach allows assessments of hypothetical designs and control alternatives, and is applicable to facilities where traditional, volume-based crash-prediction models (and norms) have not been established.

The knowledge of the vehicle's position, speed and acceleration (positive or negative) at any time should allow calculating a more relevant safety indicator than those deduced from macroscopic values.

Negative View

Microscopic traffic simulators are based on the family of car-following, lane changing and gap acceptance models to model the vehicle's behaviour. – abstraction of flow oriented driving hehaviour

In microscopic traffic simulation, incidents cannot occur as the basic modelling hypothesis in the underlying car-following models are designed to maintain a "safety to stop distance".

The usefulness of micro-simulation for safety analysis depends on the functionality of a micro-simulation model for replicating real world traffic flow and driver behavior, and calibration effort by uses.

The threshold value settings SSAM decides number of conflicts.

The drivers reaction to risk is different from normal driving behaviour.

The contributing factors are not specifically considered.

“ Thank You “