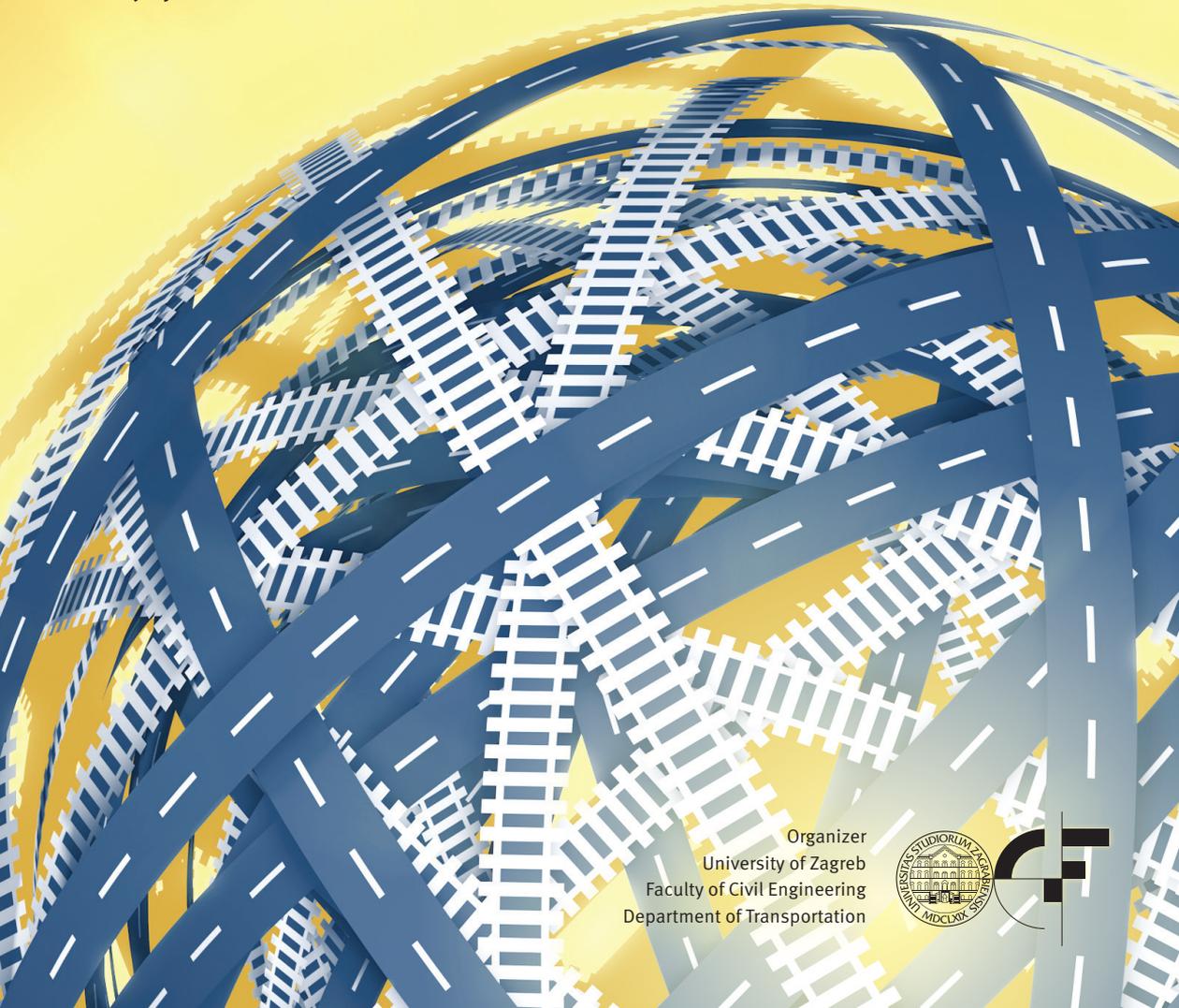


**CETRA** 2016

4<sup>th</sup> International Conference on Road and Rail Infrastructure  
23-25 May 2016, Šibenik, Croatia

## Road and Rail Infrastructure IV

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# Road and Rail Infrastructure IV

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## TRAFFIC SAFETY ASSESSMENT MODEL METHOD – SSAM

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### Abstract

Paper lists some modern models used to assess traffic safety, paying special attention to an increasingly widespread traffic safety assessment tool based on the model method, i.e. SSAM (Surrogate Safety Assessment Model). The traffic safety analysis of a road or road network segment using this model method is based on a microscopic traffic model whose precision ensures high-quality SSAM analysis. The SSAM software analyzes individual vehicle trajectories exported from the microscopic model and outputs the various interactions between individual vehicles as well as a list of all potential traffic accidents. The paper will show all the possible analyzes and results of such a traffic safety analysis. A concrete example, a connection road between the north and south bypass roads in Bled together with both roundabouts will also illustrate the theoretical part of the paper. For this example, a microscopic model has been with software tool PTV Vision, Vissim 5.40. This microscopic model was used as a basis for the SSAM traffic safety analysis. The results of analysis will be presented at the end of the paper. The results were used to improve the solution used by the main project.

### 1 Introduction

Generally, traffic safety is nowadays one of the most important and one of the most frequently mentioned aspect in modern designing of infrastructure. If we imagine the world and road transport some decades back, this was not the case. To all of traffic safety methods is common that they are about to improve accident rates on roads. Among various methods for traffic safety assessment that are listed in this paper, software tool SSAM (Surrogate Safety Assessment Model) is presented into details. SSAM method is increasingly in use in preliminary studies where different variants of solution are designed. The analysis made by software tool SSAM is then used for deciding, which variant is the best solution to be built.

### 2 Traffic safety models

In order to reduce the road accident rates that are results of inadequate designing, planning and less safe design solutions, various traffic safety models are developing globally. Generally, we can divide them in two groups of traffic safety models – Accident Prediction Models (APM) and Traffic Safety Assessment Models (TSAM) [1].

#### 2.1 Accident Prediction Models

Accident Prediction Models are mathematical formulation of traffic safety indicators according to variables, which affects on indicators. Indicators are:

- number of accidents,
- number of injuries and
- number of deaths.

Variables are:

- road length,
- road width and
- traffic load – Average Annual Daily Traffic (AADT).

Parameters of equation includes also vehicle characteristics, environment and psychophysical elements of drivers. Accident Prediction Models are mainly used for global predictions of traffic accidents, but they are based on statistical information about collision history.

## 2.2 Traffic Safety Assessment Models

Traffic Safety Assessment Models are different methodologies and software tools based on various theoretical basis. Their main use is for making decisions between different project solutions in order to select the optimal variant. Choosing the project solution on blind and waiting for statistics on actual traffic accidents is for society unacceptable, so the TSAM are right decision, how to respond to the above written thesis. There are many TSAM programs available on the market and there are quite few still developing. Some of them are listed below [4]:

- ANFIS (Adaptive Neuro Fuzzy Inference System),
- model MARVIN (Model for Assessing Risks of Road Infrastructure),
- CRF (Crash Reduction Factors),
- IHSDM (Interactive Highway Safety Design Model),
- HSM (Highway Safety Manual) and
- SSAM (Surrogate Safety Assessment Model).

## 3 Surrogate Safety Assessment Model (SSAM)

### 3.1 General

SSAM was developed in “Turner-Fairbank Highway Research Center” (McLean, Virginia, US) in association with FHWA (US Federal Highway Administration) and Siemens Energy & Automation (Tucson, Arizona, US). This tool determine the frequency and type of conflict points. As already mentioned, SSAM major advantage is that it allows traffic safety analysis of the planned road infrastructure before building it. It is also very useful when making comparative analysis [3].



Figure 1 Microscopic simulation made by PTV Vision: VISSIM

### 3.2 Working procedure [2]

For the best possible results with SSAM in detail microscopic model of study area should be developed (figure 1 shows a part of microscopic simulation mad by PTV Vision: VISSIM software tool). Microscopic model should be prepared with a program that allows us to export trajectories files of each and every single vehicle in microscopic simulation. We can choose between different programs for microscopic models. Here are some of them (PTV Vision: VISSIM, Paramics, AIMSUN or TEXAS).

The figure below shows a scheme in which SSAM works. So we need, as already mentioned, good microscopic model, from which we export trajectory files of several analysis (with minimum, middle, high and maximum traffic load and with at least three different random seeds). All this data is then analyzed with SSAM software tool.

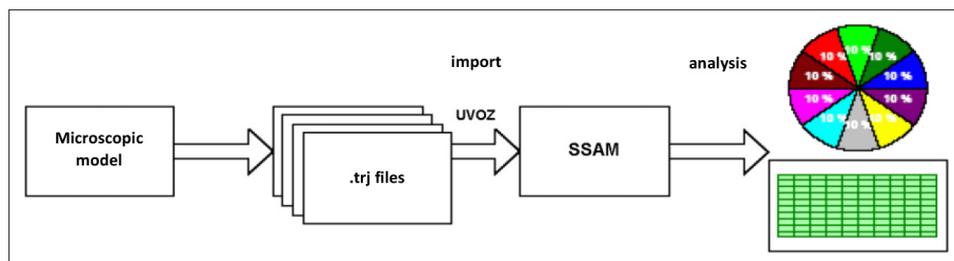


Figure 2 Scheme of work flow using SSAM

### 3.3 Results [2]

As a result of SSAM analysis we get a table of all conflicts with number of different type of conflicts and all other traffic-safety parameters values. These traffic-safety parameters are:

- TTC (time to collision),
- PET (post-encroachment time),
- MaxS (maximum speed),
- DeltaS (maximum speed differential),
- DR (initial deceleration rate),
- MaxD (maximum deceleration rate) and
- MaxDeltaV (vehicle velocity change)

Interpretation of SSAM results is very complex. All the traffic-safety parameters are heavily interconnected, correlated and complementary to each other, so none of the traffic-safety parameters by itself is not sufficient to make final conclusions and findings. For proper interpretation of the results, person with relevant experience and certain knowledge is needed.

### 3.4 Visualization of conflicts

SSAM allows some static visualization of results. You can export pictures with marked points, which represent conflicts. Usually conflicts are filtered according to parameter TTC (time to collision). SSAM allows also some additional filters that can be applied to each of the parameter and type of conflicts, which are divided according to angle of possible collision.

Figure 3 on next page represents already mentioned type of conflict according to angle between trajectories of involved vehicles.

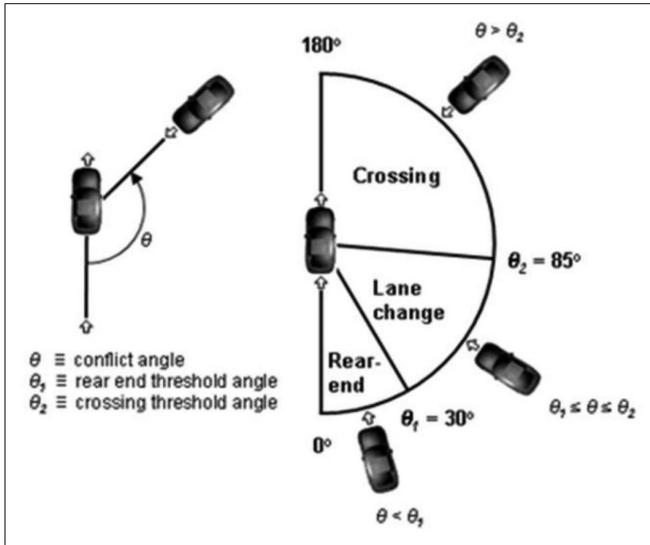


Figure 3 Conflict types by angle [2]

Figure 4 below represents example of static visualization as exported picture made by SSAM. Conflict icons are colour coded according to their time-to-collision values.



Figure 4 Visualization of conflicts

## 4 Practical example

The area of study was connection road (Ljubljanska cesta) between south and north bypass road in Bled, Slovenia. The study with SSAM was made as a comparison between three different variants of solution. The variants were:

- Variant 1: Full connection of both Gregorčičeva streets and one-sided two-way bicycle path,
- Variant 2: Full connection of both Gregorčičeva streets and two-sided one-way bicycle path,
- Variant 3: Divided connection of both Gregorčičeva streets (only with right-right maneuver possible) and one-sided two-way bicycle path.

SSAM first result is the table of conflicts. As I already mentioned, several analysis by PTV Vision: VISSIM 5.40 software tool were made with minimum, middle, high and maximum traffic load. Table 1 below represents such table of conflicts.

**Table 1** Number of conflicts for variants

% of peak hour load	40			60			80			100			Σ		
Variant	V1	V2	V3	V1	V2	V3	V1	V2	V3	V1	V2	V3	V1	V2	V3
Seasonal peak hour (2015)	2	4	3	7	14	6	14	11	17	60	49	58	73	78	84

As you can see, in seasonal peak hour load of year 2035, variant 1 have lowest number of conflicts. About display of the location of conflict on the network map, with icons of different shapes and colors assignable to different conflict types or severities has already been presented in previous chapter and on figure 4.

**Table 2** Values of other traffic-safety parameters for variants

% of peak hour load	40			60			80			100			Σ		
Variant	V1	V2	V3												
TTC	0,70	0,50	0,67	0,38	0,33	0,35	0,37	0,17	0,27	0,34	0,14	0,22	0,35	0,16	0,28
PET	1,17	0,50	0,89	0,83	0,45	0,71	0,90	0,27	0,32	0,65	0,17	0,32	0,64	0,21	0,49
MaxS	15,01	11,80	12,52	10,84	10,46	11,68	10,10	11,89	12,08	9,74	9,15	10,04	10,06	9,91	10,66
DeltaS	21,67	12,41	13,62	11,88	9,32	10,40	8,57	10,93	7,96	7,87	7,92	8,97	8,76	8,82	9,03
DR	-0,03	-1,77	-3,27	-0,90	-1,99	-3,10	-1,56	-2,70	-3,15	-1,39	-2,30	-0,65	-1,34	-2,27	-1,42
MaxD	-3,56	-2,77	-3,85	-3,42	-2,60	-3,92	-4,08	-4,61	-4,38	-1,80	-3,05	-1,61	-2,44	-3,17	-2,41
MaxDeltaV	11,37	9,58	8,19	6,68	5,86	6,16	5,31	6,33	5,23	5,50	5,30	5,63	5,74	5,77	5,68

In table 2, another more complex results of SSAM analysis is shown, which represents seven other traffic-safety parameters that have been mentioned in chapter 3.3.

### 4.1 Decision according to SSAM results

As the area of study is not so large, the interpretation of SSAM results is not that complex in shown example. As already mentioned, Variant 1 has the smallest number of conflicts and also all other traffic-safety parameters speak in favor of Variant 1 or are in the same range of values as by two other variants. Also other traffic measures speak in favor of Variant 1. The duration of delays for studied area is smallest, therefore Level of Service (LOS) is better than by other two variants. Variant 1 also have shortest columns and according to microscopic simulation Variant 1 has better transmittance than other two variants.

## 5 Conclusion

SSAM provides a compelling new option to assess the safety of traffic facilities using popular microsimulation software. This approach circumvents the need to wait for “abnormally high” crashes to actually occur, 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. Research is ongoing in this area, and as simulation models and video technology improve, this technique is expected to grow in use.

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