RIDE-model

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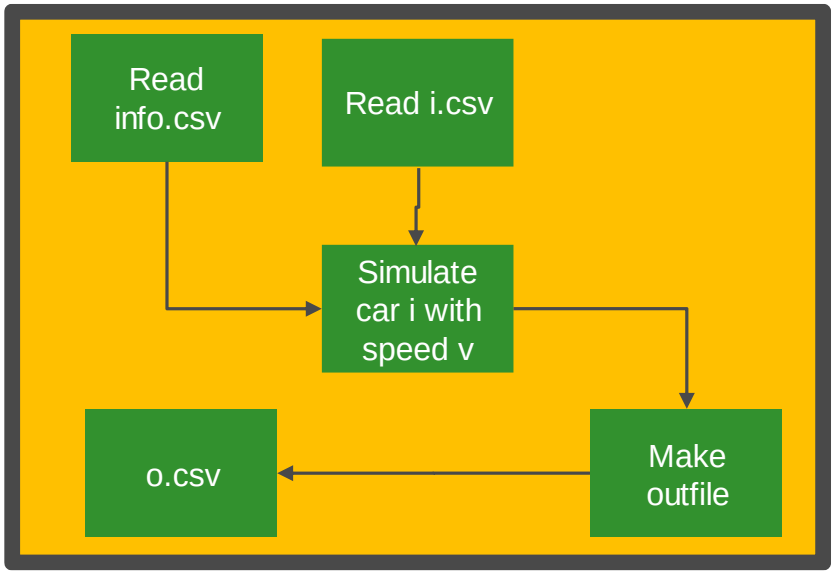

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APPENDIXES

1 GENERAL

The RIDE-model is a tool to produce vehicle responses for a given road profile with a given simulation speed. It takes as an input a file, which defines needed parameters (info.csv) and the road profile (i.csv).

To run simulations three parts, A, B and C, are needed.

- Part A is the needed software, which manages the data preparations and invokes the simulation model B. This part should be done by the user itself.
- Simulation model B is ready to be used in any Windows environment. It reads two input files (info.csv and i.csv) and makes one output file (o.csv).
- Part C is Matlab runtime environment, which is available free, and it must be installed, before running simulations. When you run the file MyAppInstaller_web.exe then it downloads the runtime environment and you need to run it once.

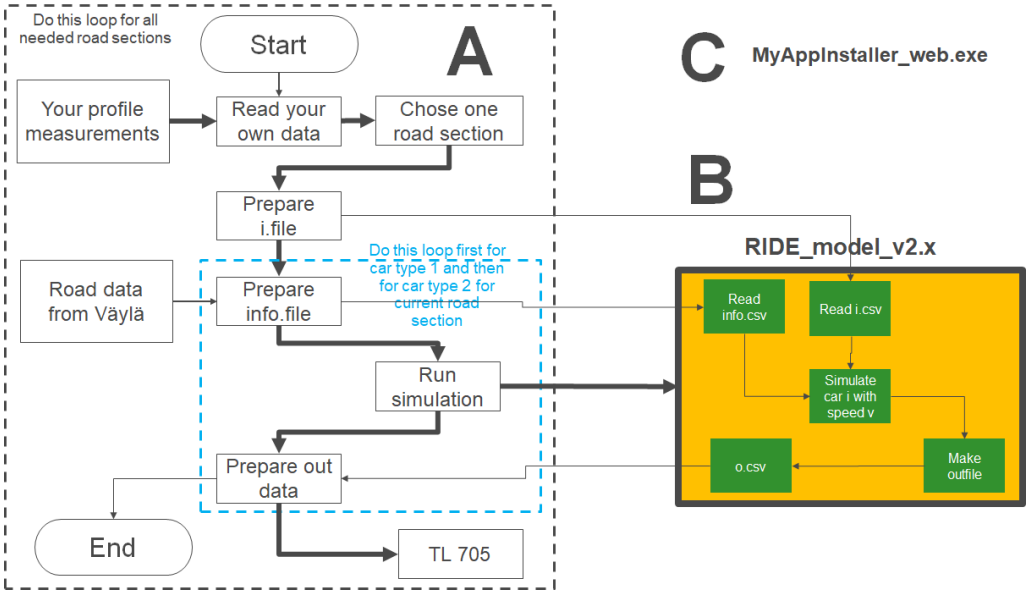


Figure 1. Framework for running the simulation model.

The simplest case for running the simulation has three steps:

1. Copy all files of the simulation package to your directory C:/xxx/ so that there is a sub-directory C:/xxx/RoadFiles/ (info.csv and i.csv)
   - Do not use C:/Program Files (x86 or without)
   - Use the folder where you have admin rights
2. Download the install-file of the runtime environment by running MyAppInstaller_web.exe and run it.
3. Run the simulation RIDE_model_v2.6_production.EXE (with the existing info and i-files).

After running the simulation model you can see your results in o.csv file. If the vehicle type in your info.csv file is 1, then simulation has been done for a car and the results are in the o.csv file. If you are going to run simulations for a truck, you need first to take the results of o.csv for car into a safe place and then run simulations for a truck, which puts results again in the same o.csv (replacing the results for a car with results of a truck). To be able to prepare the results to be uploaded to RDB you need both (car & truck) simulation results.

However, the case in reality is a little bit more complicated, because the need usually is to run simulations for several road sections in a batch-mode. For that purpose, the user

needs part A, which manages the whole process of making input files, running simulations and preparing results to be uploaded to the end customers RoadDataBases.

The user should handle this batch and its input data and invoke the RIDE program n times depending how many road sections there are on the batch.

2 INSTALLING THE SOFTWARE

Installing the software has the following steps:

1. Copy all software files to a directory, lets say C:/RIDESIM
2. Then create a sub-directory C:/RIDESIM/RoadFiles
3. And move the info.csv and i.csv files to that directory
4. Run the runtime installation program MyAppInstallation_web.EXE to download the runtime program and
5. Install that by running the downloaded program (only once)
6. The simulation program (RIDE_model_v2.6_production.EXE) is now ready to be used
7. Results are in the RoadFiles subdirectory in o.csv-file

The simulation will use simulation parameters in info.csv file and road profile data in i.csv file.

The results will come to o.csv output file without headings. Headings are available in the Headings.xls file. The output-file has several extra columns and variables, which are not needed when preparing the delivery file to FTA's RDB. Extra variables are there so far for validation and development purposes and can be skipped. Important columns are marked with red font in the Headings.xls file.

3 PREPARING INPUT DATA

3.1 Simulation parameters (info.csv)

There are two simulation parameters in the info.csv file. The vehicle type is either 1 for car or 2 for truck. The simulation speed is an individual value (40, 50, 60, 70, 80, 90, 100 or 120) for every road section depending on the actual speed limits for that particulate section (Figure 2). Do not use values between given values.

For vehicle type 1 the simulation speed is the one which has the longest length (Figure 3). For vehicle type 2 the simulation speed is min(80,speed for car type 1).

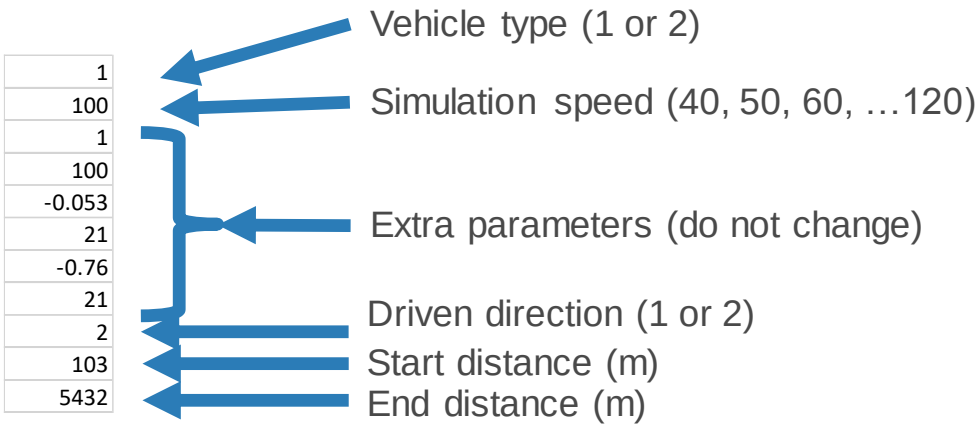


Figure 2. Data in info.csv file.

There 6 parameters, which should be kept as they are. They have certain function in filtering the road profiles. At the end part there are three numbers, one for direction, and two for start and end distances. The simulation uses these to make 10 m sections.

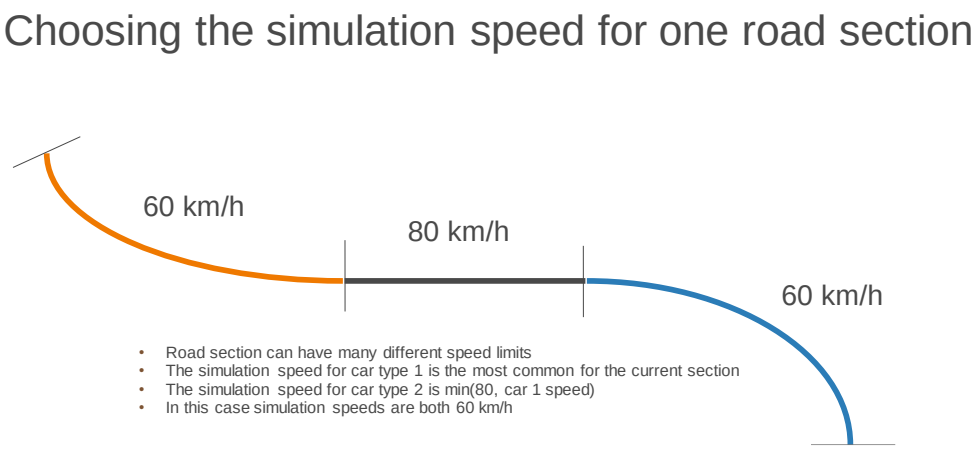


Figure 3. Choosing the simulation speed.

3.2 Road profile data (i.csv)

Each i-file should have the distance column at the first column. On the right side of distance column, there should be the road profile data for both wheel paths, left and right. In this case two columns. After profile data there should be column for curvature values and gradient values repeated for every row (10 cm).

The longitudinal road profile for left and right wheel paths, can be formed with any number of individual profiles by taking an average value for both left and right wheel paths. The number of longitudinal profiles averaged into left and right wheel paths has a small effect on simulation results. The recommended number of individual profiles are 5, for both wheel paths as is the case when measuring longitudinal profiles with 17 point lasers.

The distance can start either from 0 or any other positive number but it should be continuous with 10 cm steps without missing values, because the simulation assumes that the road profiles are continuous.

Table 1. Road profile and geometry data.

Distance (m)	LWP (mm)	RWP (mm)	Curvature	Gradient (%)
425	0	-22.3	1	-3.48
425.1	-0.6	-23	1	-3.48
425.2	-1	-23.6	1	-3.49
425.3	-1.7	-23.9	1	-3.49
425.4	-2.7	-24.3	1	-3.5
425.5	-3.4	-24.6	1	-3.5
425.6	-4	-24.8	1	-3.51
425.7	-4.8	-25.1	1	-3.51
425.8	-5.5	-25.7	1	-3.52
425.9	-5.8	-26.8	1.1	-3.52
426	-6.2	-27.6	1.1	-3.52
426.1	-6.8	-28.4	1.1	-3.52
426.2	-7.8	-28.9	1.1	-3.51
426.3	-8.7	-29.5	1.1	-3.51
426.4	-9.6	-30.2	1.1	-3.51
426.5	-9.8	-30.8	1.1	-3.5
426.6	-10.7	-31.5	1.1	-3.5
426.7	-11.8	-32.4	1.1	-3.5
426.8	-12.4	-33.3	1.1	-3.49
426.9	-12.7	-34.4	1	-3.49

Values for road profiles are relative vertical positions in mm starting from the value 0 in left wheel path. A positive value means that there is a pump upwards compared to the ground level 0 and a negative value means that there is a settlement downwards compared the ground level 0 (ISO-system).

3.3 Filtering parameters

For some cases, the longitudinal profiles are filtered to avoid the effect of the geometry of curvy and hilly roads on responses. Filtering parameters are calculated automatically in the simulation package using the curvature and gradient data.

Curvature and gradient data are both based on 1 m data for each road section and it needs to be extracted into 10 cm data. The user should produce this data using the data from the same device, which has measured longitudinal road profiles.

The sign of curvature is negative for right turning radius and positive for left turning radius, because RIDESIM uses ISO-coordinate system. That is opposite to the current data requirements for the Finnish Measurement Contract, where the basis is SAE-coordinate system.

In the straight line the curvature is (in theory) 0 but in calculations 0,1 to avoid division by zero. Curvature is calculated generally with the following formula:

$$Curvature = \frac{10000}{R}$$

where R is the radius of curve in meters measured with the inertia unit in the device and the gradient is longitudinal gradient for 10 cm distance.

Longitudinal gradient is originally a value of calculated to 1 m intervals and extracted to 10 cm intervals in percentages (0-100). Gradient in uphill is negative and downhill positive (ISO), which is opposite to the definitions for the Finnish Measurement Contract (SAE).

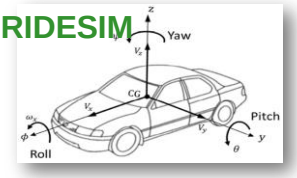
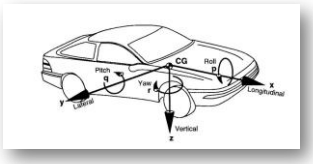
The sign of input data and responses depend on the axis system	ISO 8855, Road vehicles — Vehicle dynamics and road-holding ability — Vocabulary (1991). **RIDESIM**  *Figure 1. ISO Vehicle Axis System.*	 Figure 2. SAE Vehicle Axis System [2]
Road profile	+ up / – down	- up / + down
Curvature	+ left / – right	- left / + right
Gradient	+ down / – up	- down / + up
Roll	+ right / - left	+ right / - left
Vertical	+ up / - down	- up / + down

Figure 4. RIDESIM uses ISO coordinate system when using Road Geometry Variables.

3.4 Simulation speed

RIDE-simulations are made using the actual speed limits on each road section. Simulation with car model should be made using actual summer time speed limits. Simulations with truck model should be made with actual summer speed limits, but the individual speed limit of a truck (80 km/h) should be taken into account as well.

When a road section has several speed limits, in theory simulation should be made with all speed limits. However, to simplify calculations only one speed option should be used. In case of several different speed limits on a particulate road section, the most common one should be used (Figure 5).

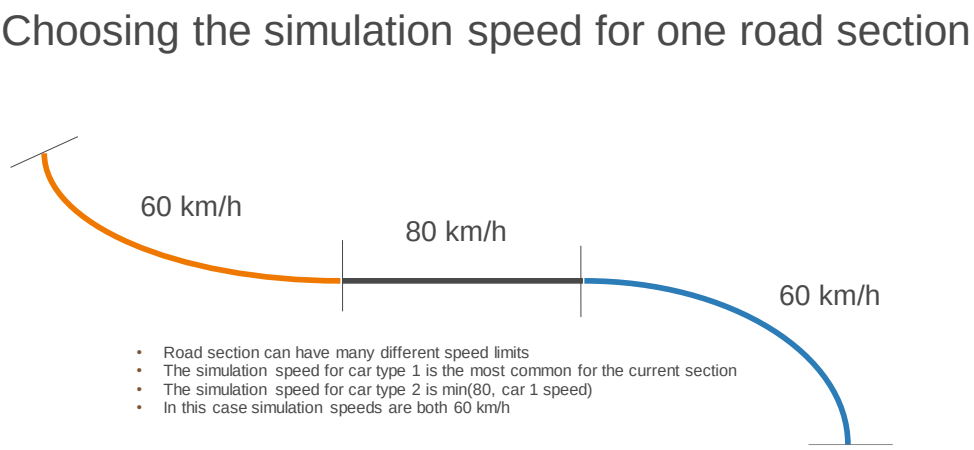


Figure 5. Most common value for speed limit in a road section.

The user should take care of existing speed limits by himself by downloading the information from RDB of the Finnish Transport Agency and calculating the most common values for each road section.

4 OUTPUT DATA

4.1 Simulation results

The results of a simulation of a road section are printed in the o.csv file. The file has 50 columns and as many rows as there are 10 m intervals on the road section. The order of rows are based on the driving direction starting from start and ending at the end. If the lane is measured in direction 2 then the final order of rows must be flipped to represent direction 1. All columns are not needed when preparing the final results but they are there by default (for other purposes). The needed columns are showed with red font in the Headings.xls file and they are explained in Chapter 3.2.

In RIDESIMv2.6 results for direction 2 are flipped to represent direction 1.

4.2 Outcomes

The needed outcomes from simulations are presented in the following table. Both simulation speeds (car & truck) should be included into results. Only the simulated energy used in shock absorbers of vehicle type 1 (car) is included. Other results should be taken from the results of vehicle type 2 (truck).

Table 2. List of outcomes from RIDE-simulations to be added to tl705 file.

sim_nop_ka	Num 3	0	Simulation speed for truck simulations (km/h)
pys_ki_std	Num 4	2	Standard deviation of vertical acceleration of truck chassi (m/s2)
siv_ki_std	Num 3	0	Standard deviation of roll acceleration of truck chassi (degrees/s2)
nyö_ki_std	Num 3	0	Standard deviation of pitch acceleration of a truck chassi (degrees/s2)
yhd_ki_rms	Num 4	2	Root Mean Square of the total combined acceleration of truck chassi (m/s2)
esal_std	Num 4	2	Standar deviation of truck ESALS
ltr_std	Num 4	2	Standard deviation of Load Transfer Ratio of truck (%)
Ityö_ka	Num 5	0	Work of shocks of a truck (J/10m)
sim_nop_ha	Num 3	0	Simulation speed for car simulation (km/h)
Ityö_ha	Num 5	0	Work of shocks of a car (J/10m)

4.2.1 sim_nop_ka

Simulation speed for truck (km/h).

4.2.2 pys_ki_std

The final indicator (pys_ki_std) is calculated as a standard deviation of vertical acceleration (m/s^2) of a chassi (VERT_a) over the reporting interval (10 m).

4.2.3 siv_ki_std

The final indicator (siv_ki_std) is calculated as a standard deviation of roll acceleration (degrees/s^2) of a chassi (ROLL_a) over the reporting interval (10 m).

4.2.4 nyö_ki_std

The final indicator (nyö_ki_std) is calculated as a standard deviation of pitch acceleration (degrees/s^2) of a chassi (PITCH_a) over the reporting interval (10 m).

4.2.5 yhd_ki_rms

Combined acceleration yhd_ki_rms is calculated as a rms-value (root mean square) of combined acceleration of a driver seat over the reporting interval (10 m).

4.2.6 esal_std

The final indicator (ESAL_std) is calculated as a standard deviation over the reporting interval (10 m).

4.2.7 ltr_std

The final indicator (ltr_std) is calculated as a standard deviation over the reporting interval (10 m).

4.2.8 ltyö_ka and ltyö_ha

ltyö_ka is the sum of energy used in shock absorbers in truck over the reporting interval (10 m). It is calculated in each shock by multiplying the velocity of the vertical movement of a corner of chassi (m/s) by the suspension coefficient c_{ij} (Ns/m) and the displacement of the spring s_{ij} (m). **ltyö_ha** is the same but with car parameters. The unit is Joule/reporting interval.

4.2.9 sim_nop_ha

sim_nop_ha is the simulation speed (km/h) used for car model.