CORSIM Calibration Parameters

Last Revision: July 8, 2002

The CORSIM model is a microscopic simulation model that uses car following theory based on vehicle headways. Thus the calibration parameters are related to both vehicle and driver characteristics.

There are three (3) stochastical *vehicle entry headway* choices; uniform distribution, normal distribution, and Erlang distribution. This is the method the program will use to generate vehicles at entry nodes. The default setting is a uniform distribution, but the preferred choice is a normal distribution for arterial and Erlang for freeway. For the Erlang Distribution, the parameter "a" is set to 1.

The main calibration parameters for the CORSIM model are the vehicle type characteristics found under the Network Properties menu. Up to nine (9) different types of vehicles can be simulated by the model. Four (4) different classes of vehicles can be modeled; auto, truck, transit, and carpool. For Mn/DOT modeling purposes, the following vehicles have been adopted:

1. 15' long auto.
2. 30' long single unit truck (SUT).
3. 62' long semi-trailer.
4. 40' long transit bus.

The main variables for the vehicle types include:

1. maximum non-emergency deceleration.
2. maximum emergency deceleration.

The model to determine the headway between vehicles uses the maximum deceleration rates. Altering these rates gives the user some control over the density of the system. The maximum deceleration rate of the program has been capped at 15 ft/s^2. For the vehicles listed above, the following deceleration rates have been selected as beginning points for calibration:

Vehicle Type	Max. Non-Emergency Deceleration	Max. Emergency Deceleration
	ft/sec^2	ft/sec^2
15' auto	13.1	15.0 (actual = 23.0)
30' SUT	9.8	15.0 (actual = 16.4)
62' semi	7.9	12.5
40' bus	9.8	15.0 (actual = 16.4)

The physical make-up of the traffic can also be entered. At entry links, the truck percentages can be entered. Within the vehicle type characteristics, the user can define the make-up of each vehicle class for either arterial or freeway systems. This is entered as a percentage and the sum of the percentages must equal 100 for each vehicle class. For example, the truck class could be entered as 65% SUT and 35% semi-trailers. Current truck percentage by time of day and direction are available through Mn/DOT by contacting Jim Hendrickson at (651) 234-7782.

FRESIM parameters include driver behaviors, lane change parameters, and model parameters. These are best left in their default settings. The one model parameter that can be modified is the *minimum separation for generation of vehicles* parameter. This is the minimum time the model uses to produce vehicles at entry links and is the only parameter that controls freeway capacity. But, this is only true at the entry links and does not affect the other links in the modeled system. Entered in seconds, this parameter has a default value of 1.6 seconds that equals a capacity value of 2250 vplph.

To determine this parameter, the mainline entry point detector volumes, in vph, are plotted against their occupancy rates. From this graph, the maximum volume is determined and is divided into 3600. Auxiliary lane detectors should not be included in this calculation.

At ramps and when there is more than one capacity for the mainline system, the car-following sensitivity multiplier for that link can be adjusted to meet the existing link capacity. By increasing this value, the link capacity is decreased. By reducing this value, the link capacity is increased.

There are a large number of parameters for NETSIM including several parameters for driver behaviors. All of these should be left in their default settings. The Pitt car following constant should be left at the default value of 10.

Calibration Process:

1. Calculate the average volumes for ramp entry and exit points and mainline sections representing detector stations. This is done for each time interval.
2. For each detector location, graph the simulated volume and detector volumes against time. Visually inspect graphs for large differences in volumes and for simulation delays.
3. Calculate residual errors for each time interval for each ramp and detector station. Check for large residual errors occurring at entry ramps and exit ramps. These are indications of volume coding errors, particularly at entry links. When the residual errors are within 10% of the detector data, the simulated volumes are considered acceptable.
4. Recheck volume data in simulation files after the first run to check for possible coding errors suggested by the graphs and/or residuals.
5. Calculate the average speed for mainline sections representing detector stations. Calculate the estimated detector station speed from the vehicle count and occupancy data using the speed equation found later in this paper. This is done for each time interval.
6. Compare mainline speeds at the detector stations to verify the model is simulating the same congestion levels as the mainline detectors. When the simulated speeds

are within 20% of the estimated detector station speeds, the speeds are considered acceptable.

7. Compare the actual ramp queue lengths with the simulated values to verify that ramps are servicing the same number of vehicles. Difference could be coding error on ramp speed or value.

Remember that when calculating the simulated volumes and speeds, the FRESIM output is cumulative.

We strongly suggest that the following statistical testing be performed to calibrate the model. This is currently not a requirement but will be in the future.

8. Calculate the U-Statistics for each detector station.
9. If the U-Statistics are not acceptable, modify the calibration parameters and repeat steps 1 to 4. Otherwise continue to step 5.

If the U-Statistics and speed comparisons are acceptable, the model is calibrated. Otherwise modify the calibration parameters and return to step 1. Continue to step 6.

Test Statistics:

Residual errors of the simulated volumes are calculated for each time interval as:

$$RES_i = \left| SIM_i - DET_i \right|$$

where:

SIM_i = the simulated volume (vph) for time interval "i".
DET_i = the measured volume (vph) for time interval "i".

The residual errors are calculated for each entry and exit ramp in order to check the flow rates at these locations. The residual errors are also calculated at each detector station as the initial comparison between simulated and actual volumes.

The main test statistics are Theil's U-Statistics. The first index, U_m, checks the model's ability to estimate the existing traffic volumes. The second index, U_s, checks the model's ability to recreate the variability of the detector data. The third index, U_c, checks. These indices are calculated as:

$$U_m = \frac{(M_S - M_D)^2}{D_n^2}$$

$$(S_S - S_D)^2$$

CORSIM Calibration Parameters

$$U_s = \frac{}{D_n^2}$$

$$U_c = \frac{2(1-\rho)*S_S*S_D}{D_n^2}$$

$$\rightarrow \quad U_m + U_s + U_c = 1$$

where:

Ms = sample mean of the simulated volumes.
Md = sample mean of the measured volumes.
Ss = sample standard deviation of the simulated volumes.
Sd = sample standard deviation of the measured volumes.
ρ = sample correlation between the simulated volumes and the measured volumes.
D_n^2 = average squared error.

The average squared error is calculated as:

$$D_n^2 = \left[\frac{1}{n}\right] \sum_{i=1}^{n} (SIM_i - DET_i)^2$$

where:

n = the number of time intervals.

The U_m and U_s indices both must be below 0.10 and the U_c index must be above 0.90 for each detector station before the speed comparison can be checked.

Mainline detector speeds are calculated using the occupancy rates of the detectors. The speeds for each time interval are calculated in mph as:

$$SPD_i = \frac{(100 * 3600 * VOL_i * (L_V + L_D))}{(T_i * 5280 * OCC_i)}$$

where:

L_V = length of typical vehicle in feet.
L_D = length of detector in feet.
T_i = length of time interval “i” in seconds.
OCC_i = measured occupancy for time interval “i”.

CORSIM Calibration Parameters

VOL_i = measured number of vehicles crossing detector for time interval “i”.

An average speed is then calculated for all of the detectors in a station and that average is compared to the simulated value to check if the simulation is operating on the correct side of the flow/density curve.

Please contact Kevin Sommers if you have questions about the calibration process or need assistance with the statistical tests. Kevin Sommers can be reached at (651) 234-7844 or kevin.sommers@dot.state.mn.us.

Reference Materials

1. O. Balci. “Verification, Validation and Testing,” a Handbook of Simulation: Principles, Methodology, Advances, Applications and Practice, “ Ed. By J. Banks, John Wiley, 1998.

2. J.P.C: Kleijnen. “Theory and Methodology: Verification and Validation of Simulation Models,” European journal of Operational Research, Vol. 82, pp. 145-162, 1995.