

Technical review of R51-03 phase3 in Japan

◆ Targets

- ✓ To achieve 100% in the EQSs (Environmental Quality Standards) for Road Traffic Noise
- ✓ To reduce the number of complaints related to vehicle noise

EQS: An administrative goal set as a standard that should be maintained for the protection of human health and the preservation of the living environment, and the standard value is set for each area type and time category.

◆ Technical review of R51-03 phase3

- ✓ Before introducing phase3, the following studies are now being conducted in Japan
 - ➔ To assess the effectiveness of phase3 introduction at the points exceeding EQSs, by using JARI prediction model
 - ➔ To conduct a survey of automobile manufacturers regarding the impact of phase3 introduction, etc

- ✓ To sort out what is important as noise countermeasures beyond phase3, we would like to continue to share our issues and initiatives including the technical review of phase3 in Japan.
- ✓ We are planning to report an result of the review at TF-VS early next year.

Road traffic noise prediction model based on micro traffic flow model

Japan Automobile Research Institute (JARI)

Overview of the road traffic noise prediction model

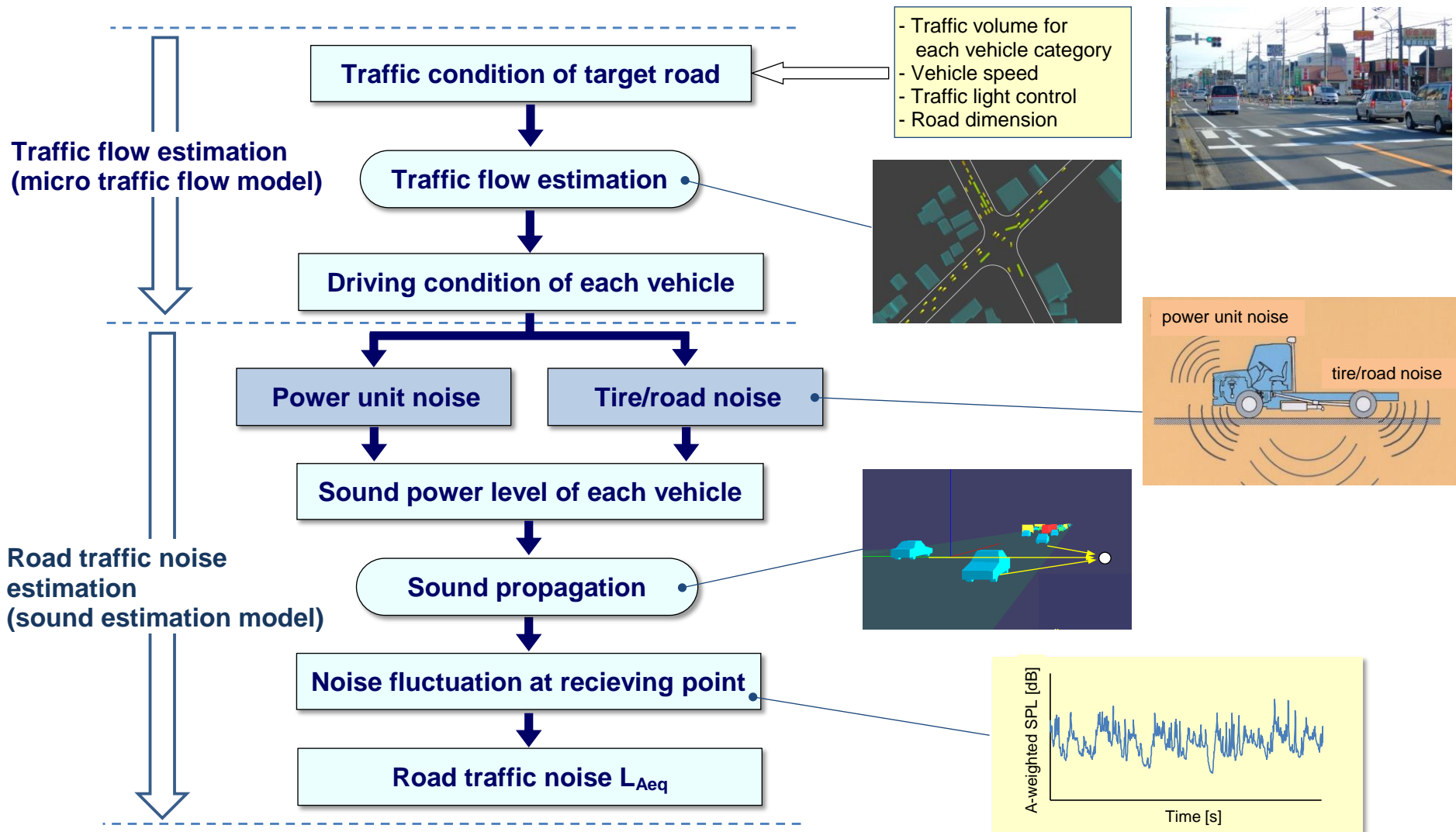
Overview of the model

- ◆ This road traffic noise prediction model is a combination of "micro traffic flow model" and "sound estimation model".

Features




- Power unit noise and tyre/road noise are treated as individual sound sources.
- Running conditions and generated noise of individual vehicles in the traffic flow are considered.
- Fluctuation of road traffic noise at sound receiving point is calculated by summing up the sound propagates from each vehicle.
- Since the effect of noise reduction for each sound source can be calculated individually, this model is suitable for estimating the effectiveness of vehicle noise measures.

Calculation flow

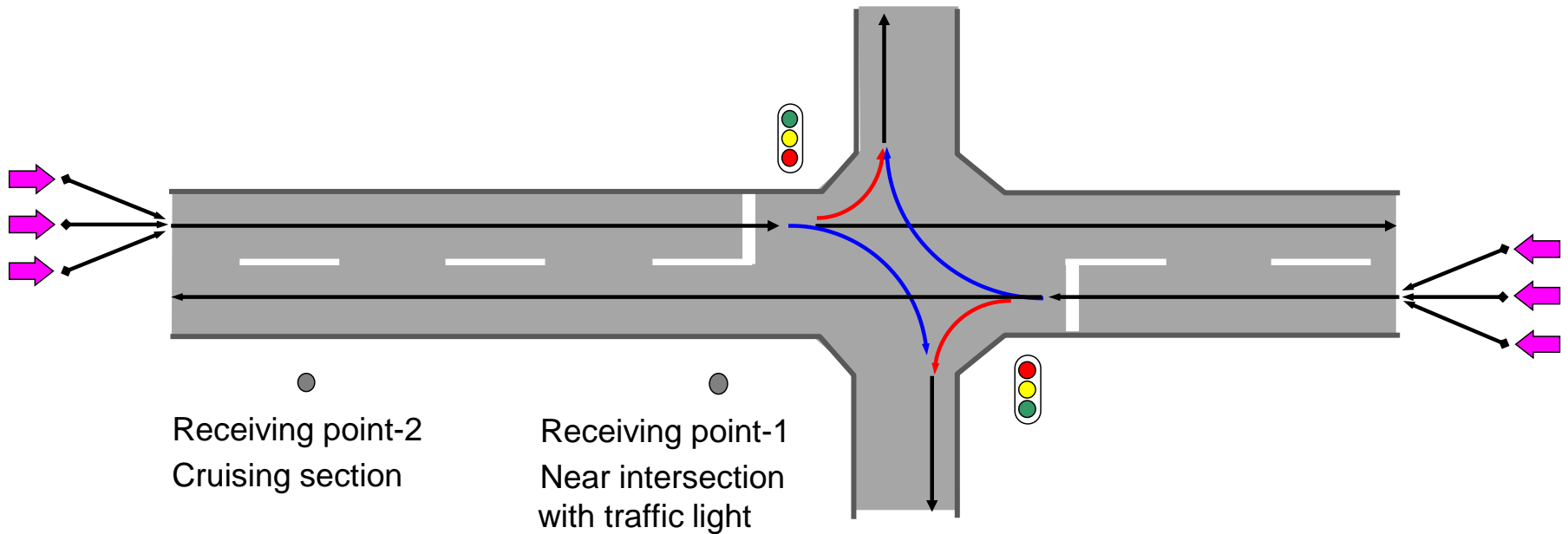


Traffic flow estimation

Input data to the traffic flow model

-  Inflow traffic volume of each vehicle category by each route
-  Vehicle speed when cruising in each section
-  indication time of traffic lights and phase difference between them
- Number of lanes, road dimensions, etc.

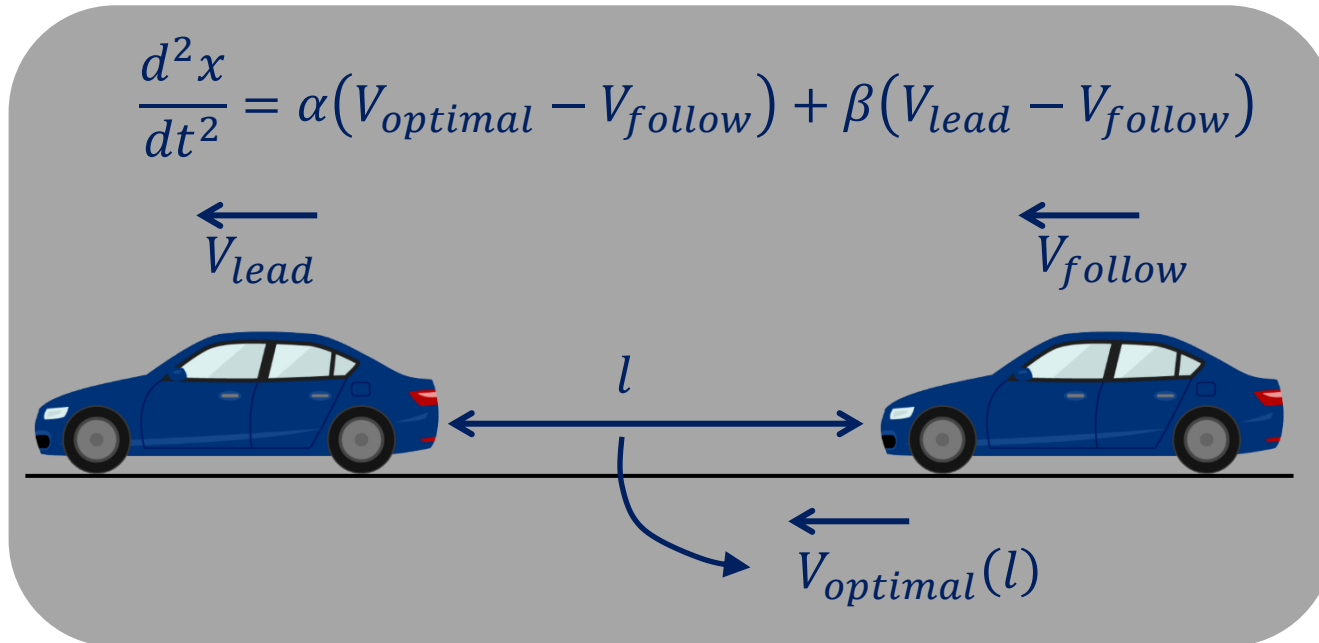
To simulate actual traffic flow, these values are set based on the traffic flow survey results



Micro traffic flow model (car following model)

- In the micro traffic flow model, car following model was adopted.
- Running condition of a following vehicle is estimated based on that of a leading vehicle.

Running Condition: vehicle position, speed, acceleration, engine speed and engine load



The coefficients α and β were determined based on the actual driving survey.

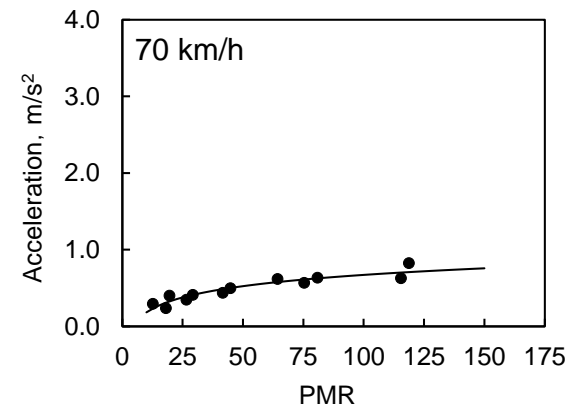
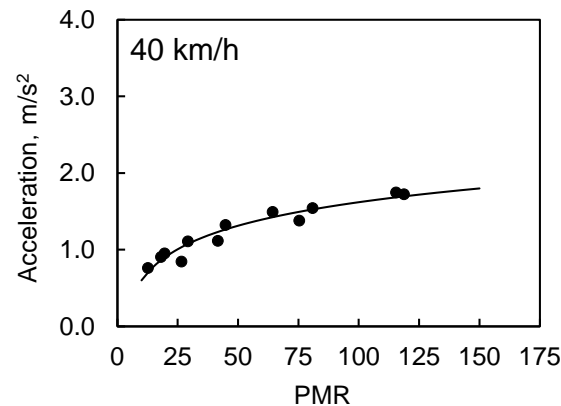
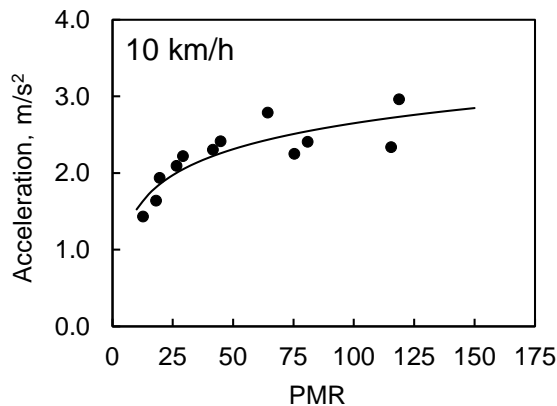
Micro traffic flow model (Leading vehicle)

The acceleration of the leading vehicle that accelerates from the intersection is calculated by the following formula based on the results of the driving mode survey in urban areas.

$$a = 3.30 - 2.15 \log_{10}(V) + 0.77 \log_{10}(PMR)$$

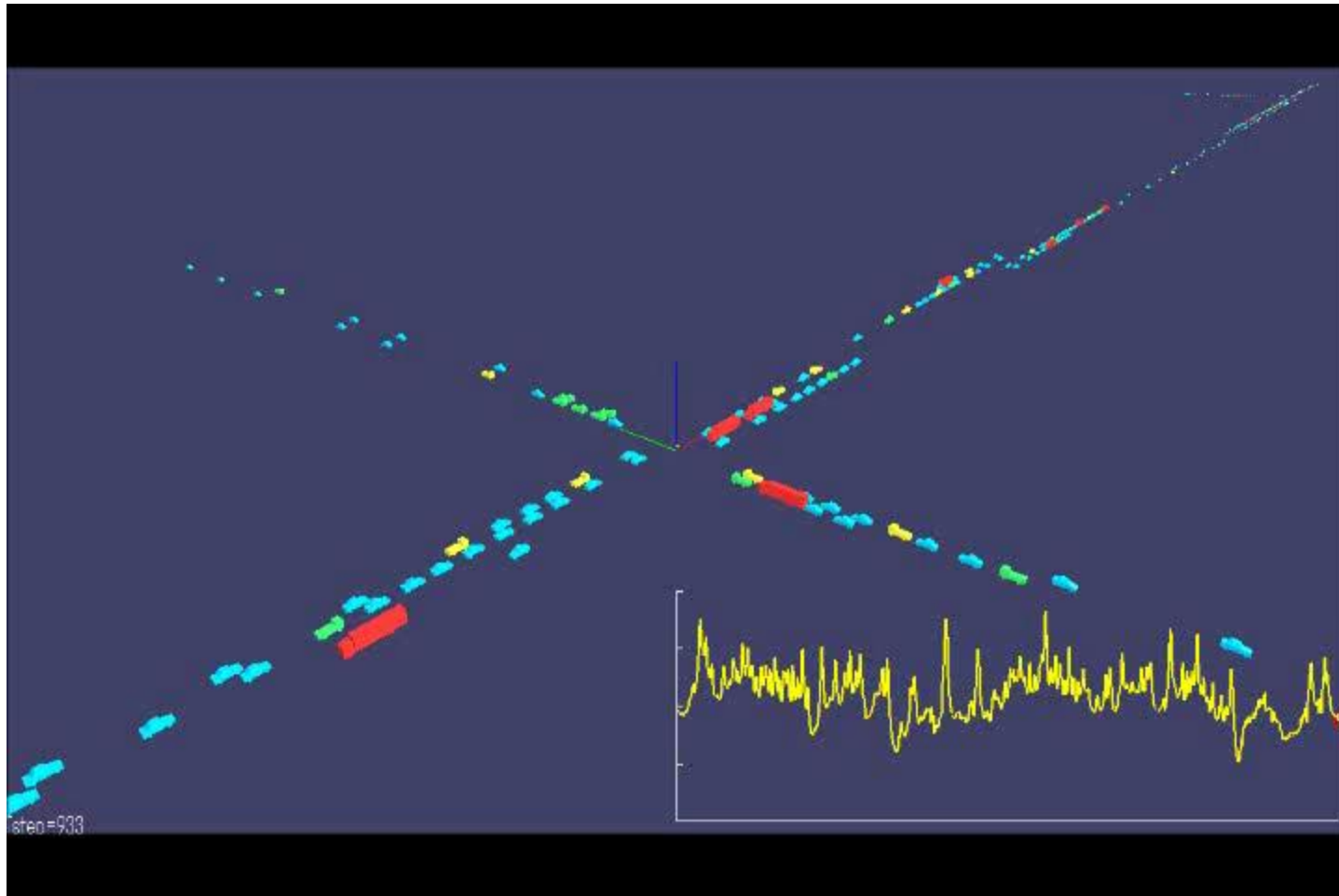


Excerpt



GRB-35-inf06 (2001.09,JPN)

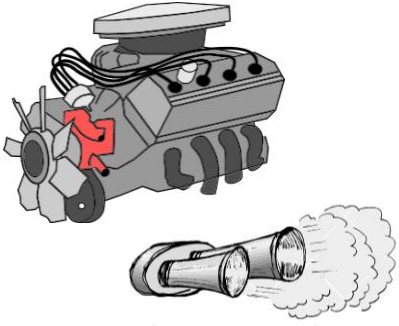
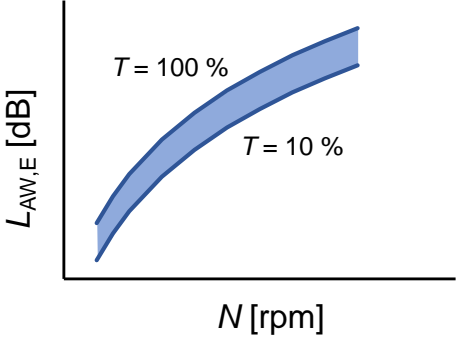
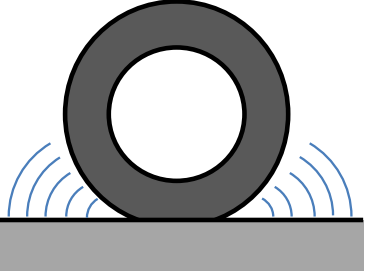
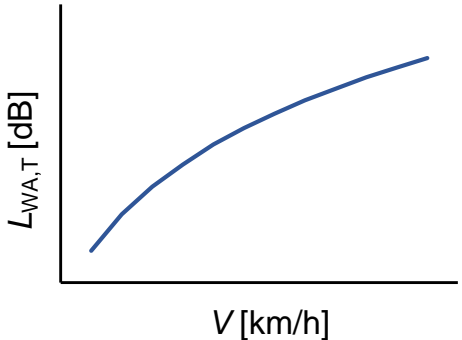
Result of traffic flow estimation



Road traffic noise estimation

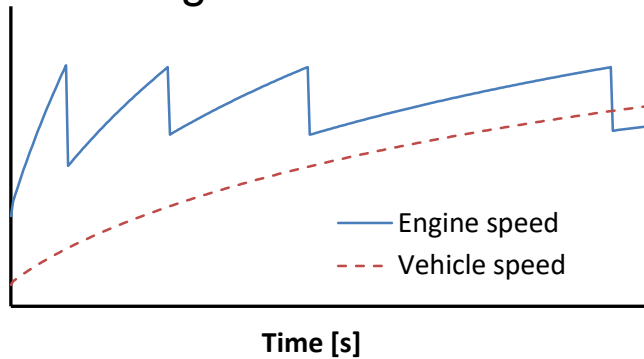
- Setting of sound sources and sound propagation calculation**

Expression of sound power level for each sound source

| Sound source | Experimental equation of sound power level | |
|---|--|--|
| <p>Power unit noise</p>  | $L_{WA,E} = A_0 + A_1 \log_{10} \frac{N}{N_0} + A_2 T$ <p> N : Engine speed [rpm] N_0 : Reference engine speed (=1rpm) T : Engine load [%] $A_0 \sim A_2$: Regression coefficient </p> |  |
| <p>Tyre/road noise</p>  | $L_{WA,T} = B_0 + B_1 \log_{10} \frac{V}{V_0}$ <p> V : Vehicle speed [km/h] V_0 : Reference vehicle speed (=1km/h) B_0, B_1 : Regression coefficient </p> |  |

Running condition and radiated sound power level

Running conditions

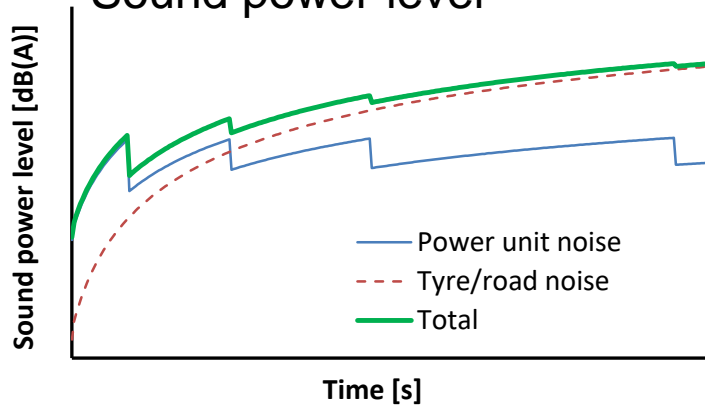


Change of engine speed and vehicle speed obtained as a output of traffic flow model

Time [s]



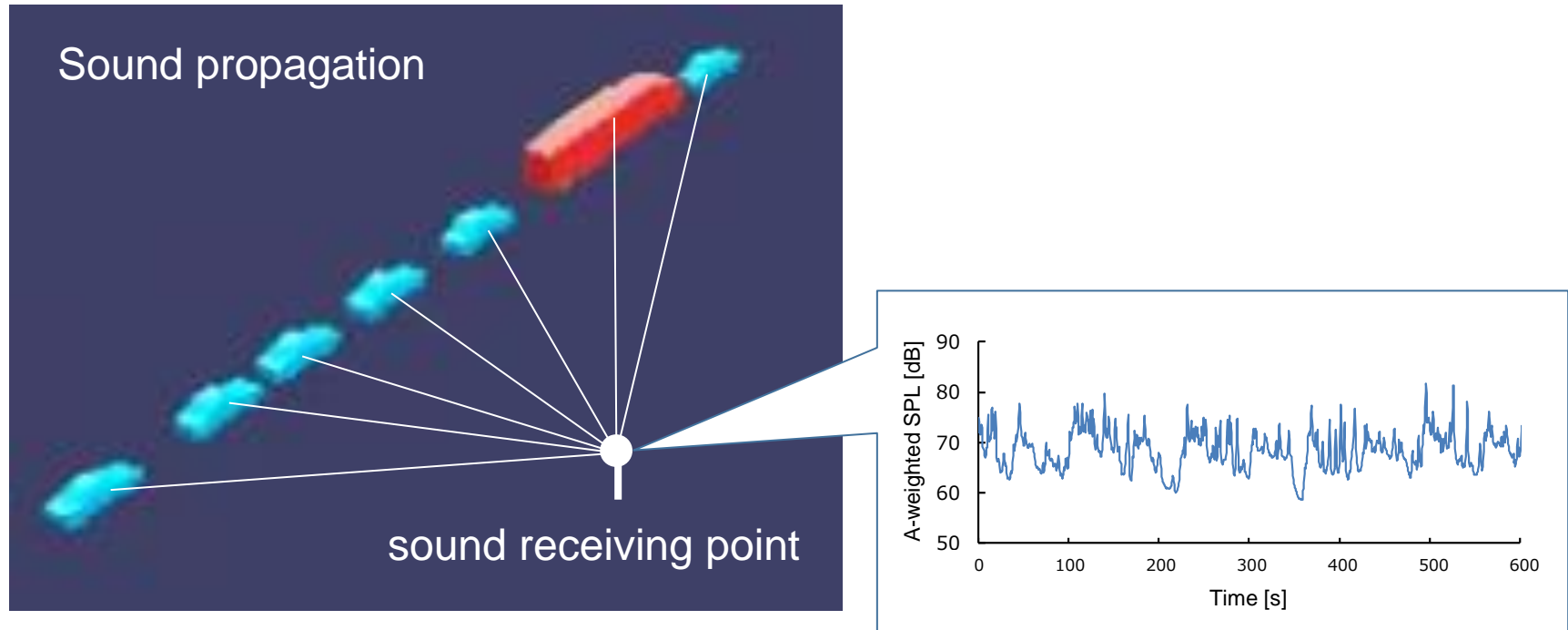
Sound power level



Calculated sound power levels based on the running condition above and sound power level equations

Time [s]

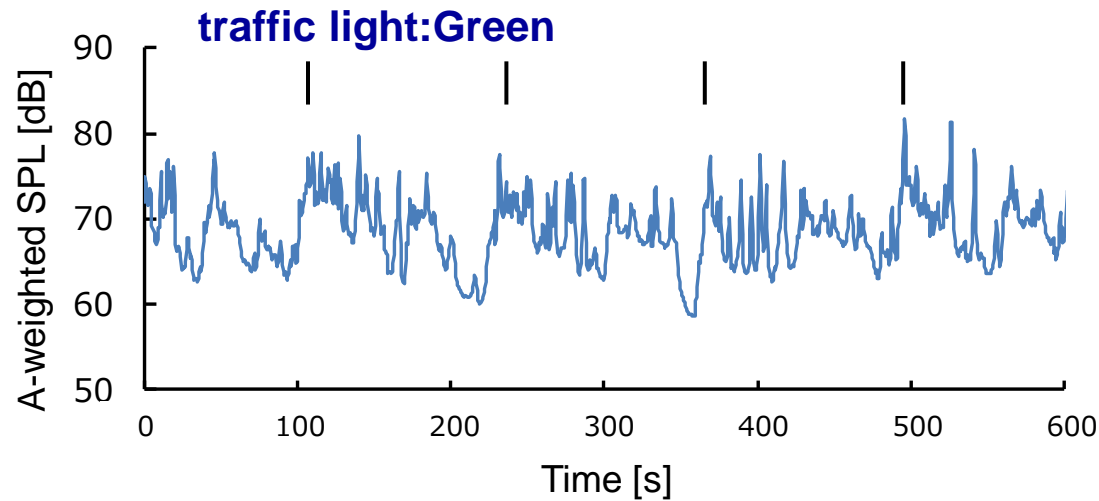
Sound propagation from vehicles to sound receiving point



Sound level at the sound receiving point is calculated by summing up the sound propagates from all vehicles. By repeating such calculations over time, fluctuations in road traffic noise can be obtained.

Predicted result of road traffic noise

Time series fluctuation of sound level at sound receiving point

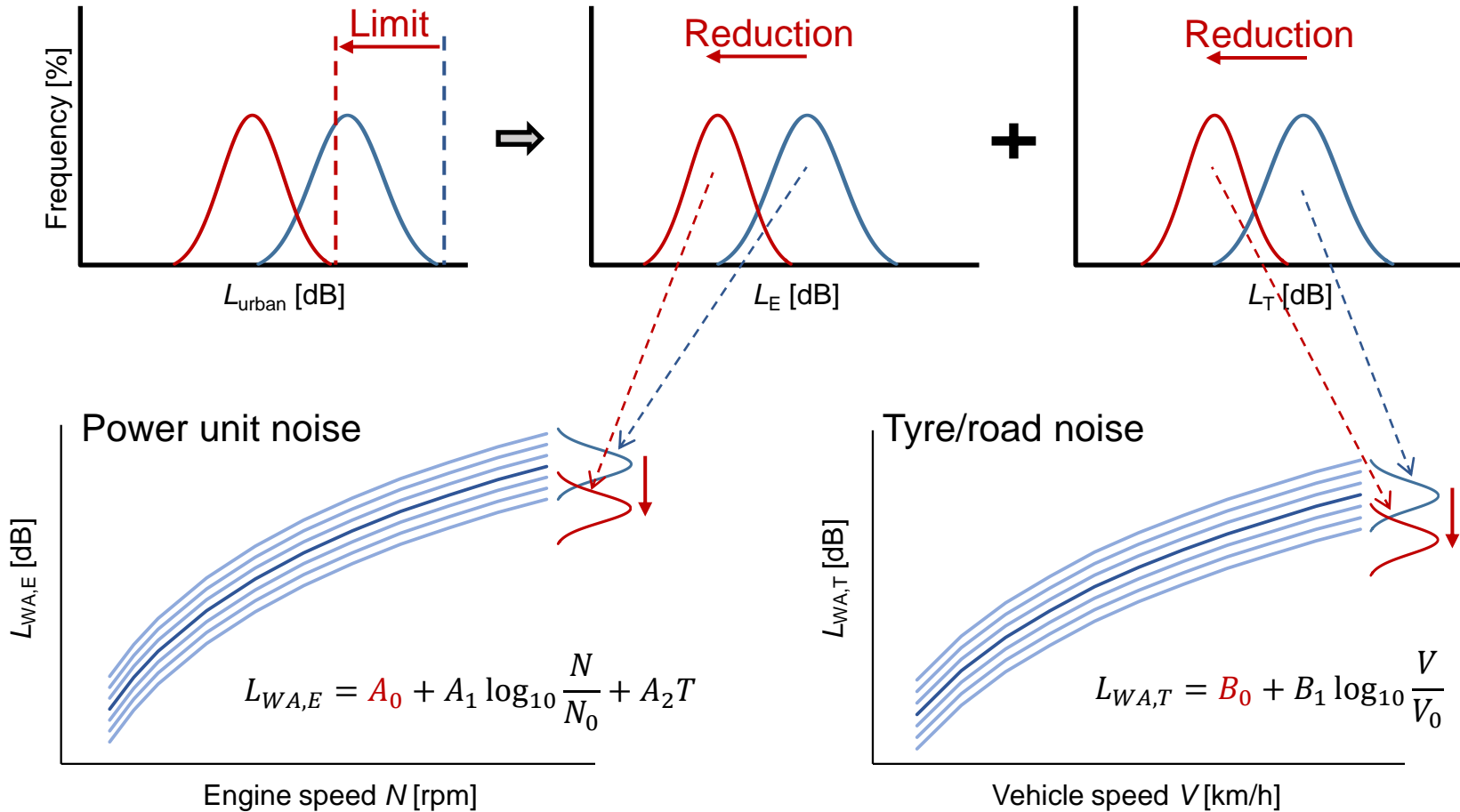



Calculation of L_{Aeq}

$$L_{Aeq} = 10 \log \frac{1}{T} \int_{t_1}^{t_2} \frac{p_A^2(t)}{p_0^2} dt$$

Setting for estimating the effect of tightening limit value

Distribution of L_{urban} \Rightarrow L_E (Power unit noise) + L_T (Tyre/road noise)

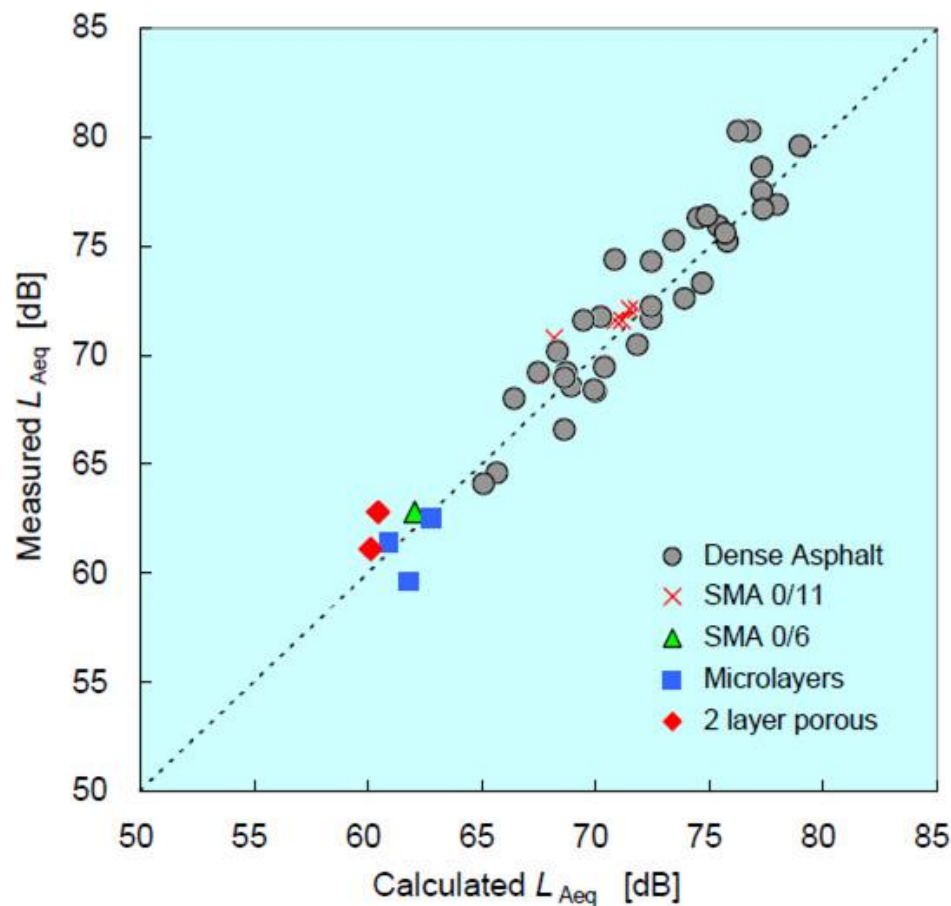


The values and frequency of the coefficients A_0 and B_0 are set according to the level distribution of each sound source; 

Road traffic noise estimation

-- Validation of calculation results

Validation: Comparison of measured and calculated L_{Aeq}



The coefficients of tyre road noise on several types of road surfaces were set based on the relationship between vehicle speed and pass-by noise measured on public roads.

References

- 1) Y. Oshino, K. Tsukui and H. Tachibana, "Prediction of road traffic noise taking account of transient running conditions of vehicles -Part 1. Relationships between running conditions and noise radiation-," *J. Acoust. Soc. Jpn. (J)*, 50, pp. 205-214 (1994) (in Japanese).
- 2) Y. Oshino, K. Tsukui and H. Tachibana, "Prediction of road traffic noise taking account of transient running conditions of vehicles -Part 2. Simulation of traffic flow and calculation of noise propagation-," *J. Acoust. Soc. Jpn. (J)*, 50, pp. 977-985 (1994) (in Japanese).
- 3) K. Tsukui, Y. Oshino, G. van Blokland and H. Tachibana, "Study of the road traffic noise prediction method applicable to low-noise road surfaces," *Acoust. Sci. & Tech.* 31, 1, pp. 102-112 (2010).
- 4) T. Suzuki, Y. Oshino and H. Tachibana, "Road traffic prediction model around intersection taking account of right- and left- turn traffic," *J. Acoust. Soc. Jpn. (J)*, 60, pp. 526-535 (2004) (in Japanese).
- 5) T. Suzuki, K. Tsukui, Y. Oshino and H. Tachibana, "Road traffic prediction model around signalized intersections," *Proc. Inter-noise 2003*, pp. 1870-1873 (2003).