

Study of $v * a$ Concept

ASEP Informal Working Group #3

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JASIC

Contents

- Physical meaning of $v * a$
- Relationship between $v * a$ and vehicle sound
- Issue for non-locked gear ratio test
- Summary

What does $v * a$ mean?

$$\begin{aligned}
 a * v &= \frac{F}{m} * v & \text{where } F = m a \\
 &= \frac{1}{m} \frac{T}{r} * v & \text{where } T = Fr \\
 &= \frac{1}{m} \frac{T}{r} * r \omega & \text{where } v = r \omega \\
 &= \frac{T \omega}{m} & \text{where } T \omega: \text{ power}
 \end{aligned}$$

a : acceleration rate
 v : vehicle speed

F : driving force
 m : vehicle mass

T : driving torque
 r : tyre radius
 ω : angular velocity

$$a * v = \text{Engine power /mass (PMR)}$$

$a * v$ can indicate vehicle performance.

Vehicle sound level;

$$L = L_T + L_E = f(v, n, l)$$

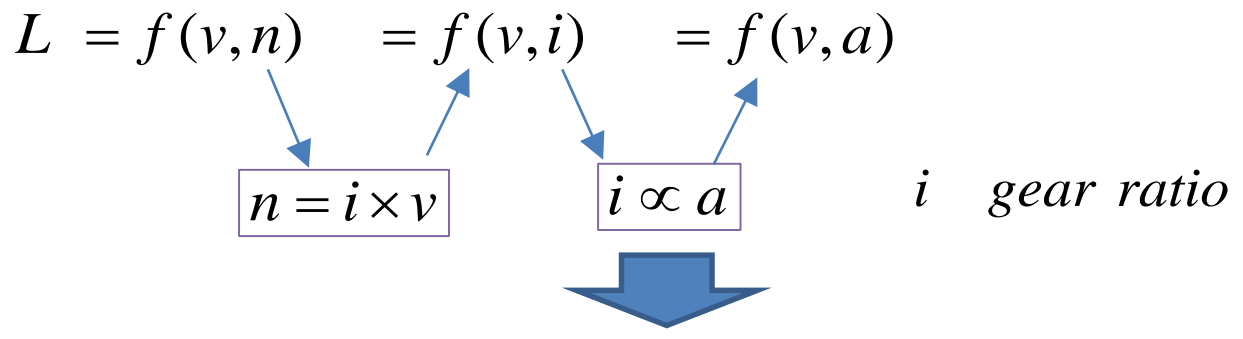
if $l = WOT(100\%) = const.$

}	Tyre noise	$L_T = B_0 + B_1 \log \frac{v}{v_0}$
	PT noise	$L_E = A_0 + A_1 \log \frac{n}{n_0} + A_2 l$

v : Vehicle speed (km/h)
 v_0 : Reference speed (1 km/h)
 B_0, B_1 : coefficients

 n : Engine speed (rpm)
 n_0 : Ref. engine speed (1 rpm)
 l : Load factor (%)

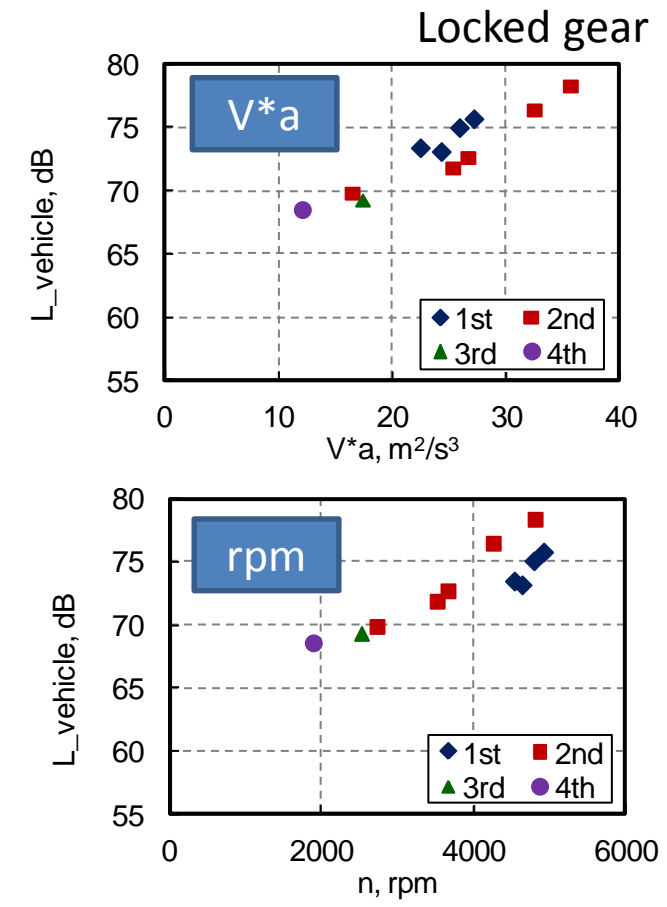
 A_0, A_1, A_2 : coefficients



- Checking sound behavior within one gear, acceleration is not function of sound level but constant.
- Using different gear, gear ratio can be used instead of acceleration.

The result of vehicle sound vs $v * a$ or rpm is same.

In case of WOT test, engine speed can be used without $v * a$.

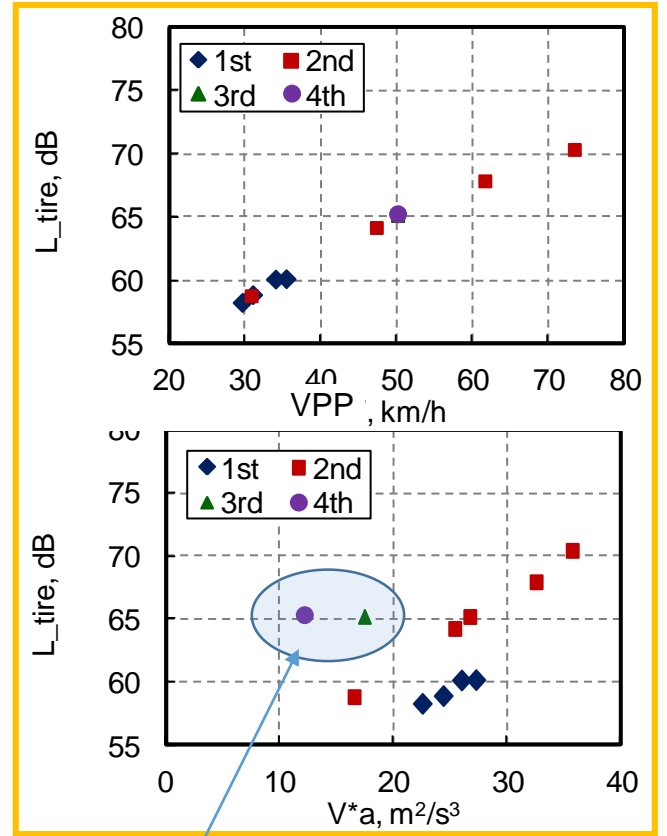
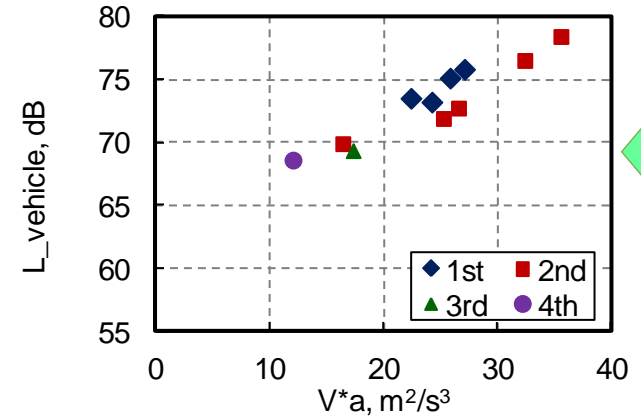
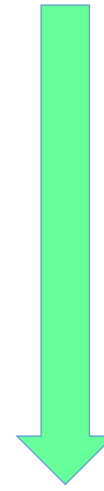


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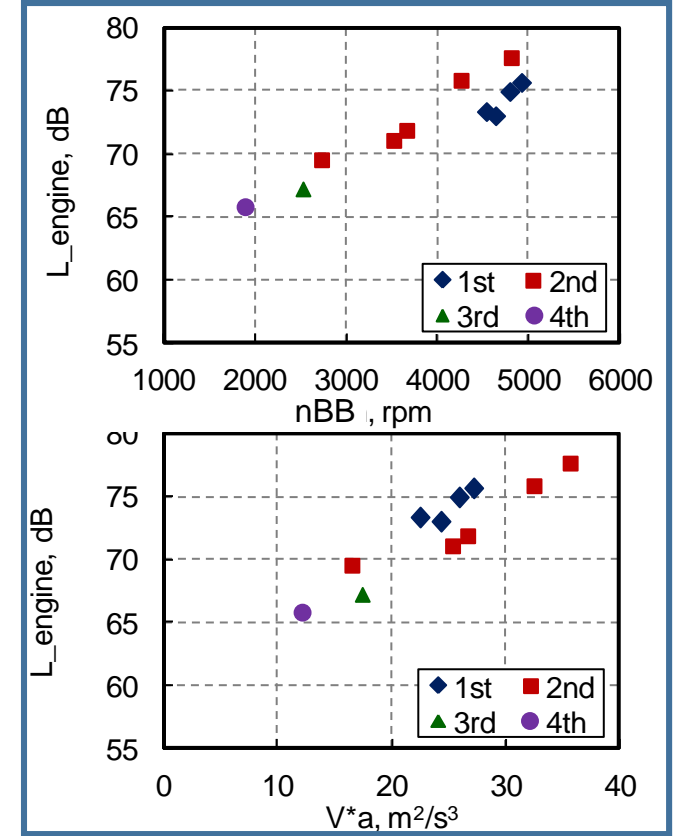
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Vehicle noise = Tyre noise + PT noise

Higher $v * a$ (PMR), higher vehicle noise level.

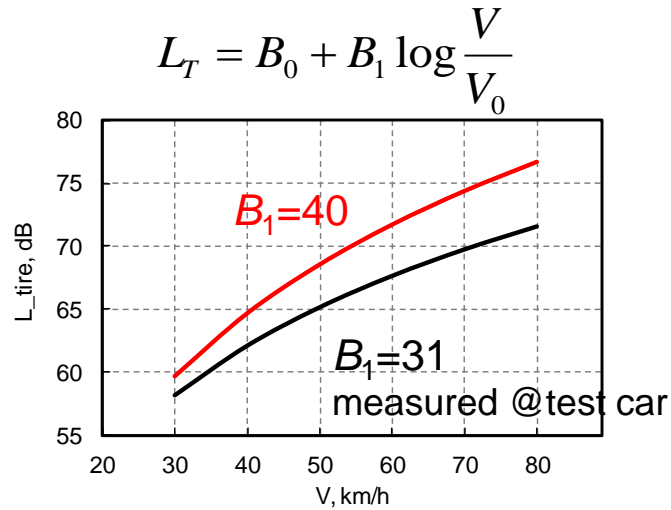


Influence of tyre noise at Higher gear and higher vehicle speed?



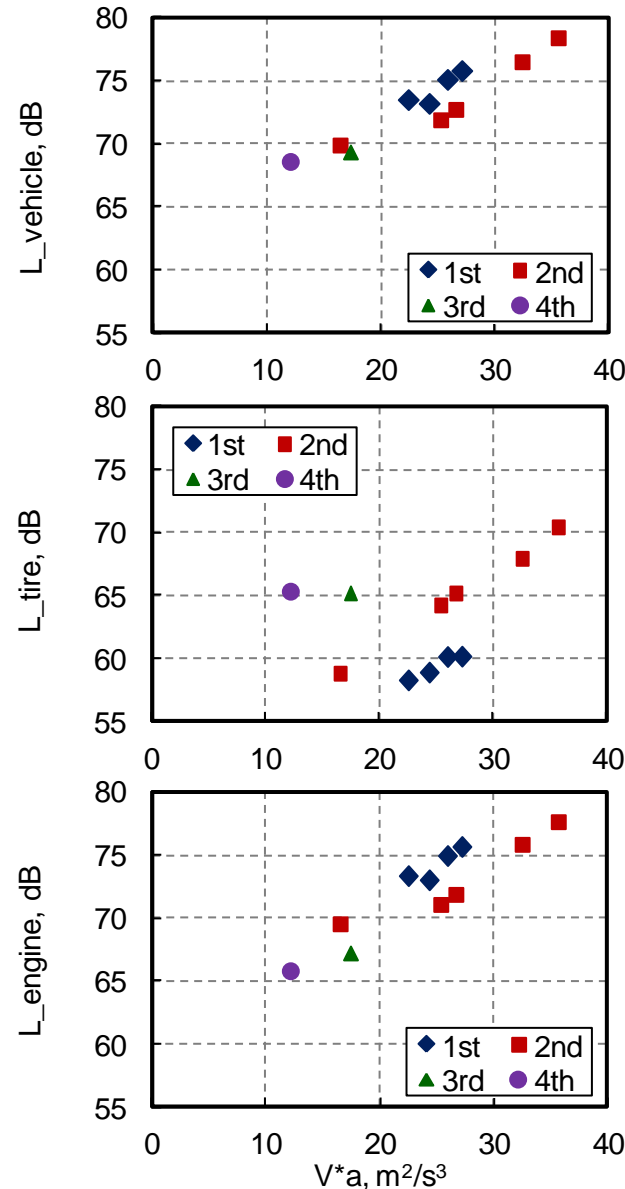
Good relation between $a * v$ and PT noise.

Influence of Tyre noise

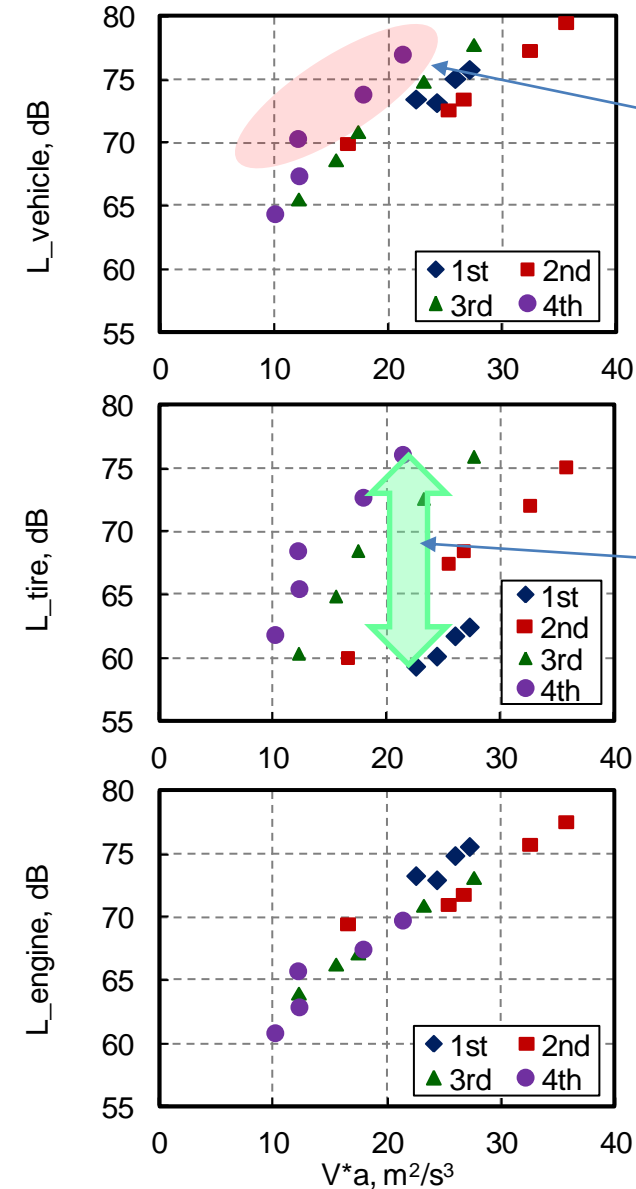


If higher gear test is needed for ASEP, it is not negligible for tyre noise influence.
Tyre must not be concern for ASEP.

$B_1=31$:
measured @test car



$B_1=40$



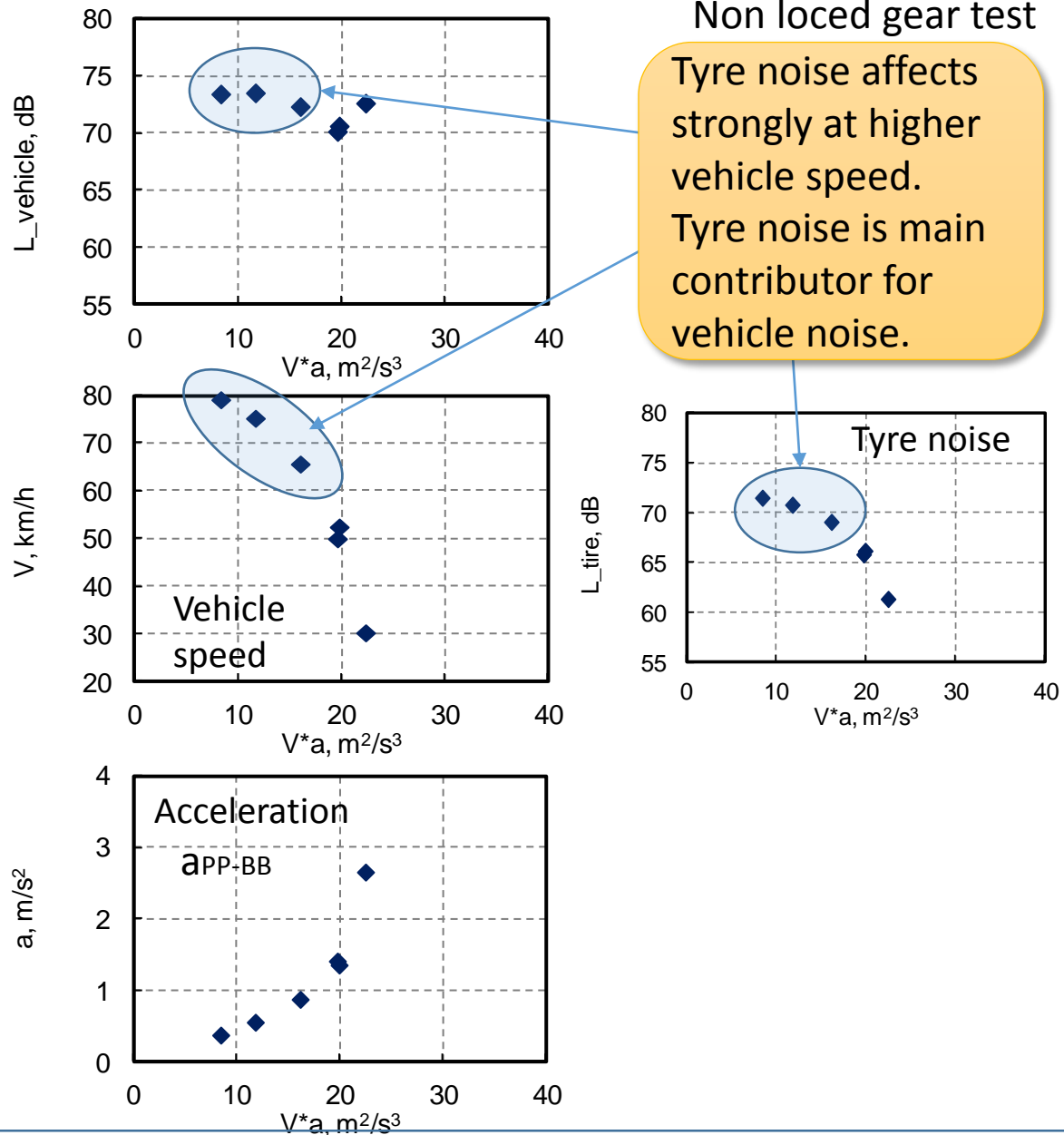
Influence of tyre noise in 4th Gear.

Large range of tyre noise.

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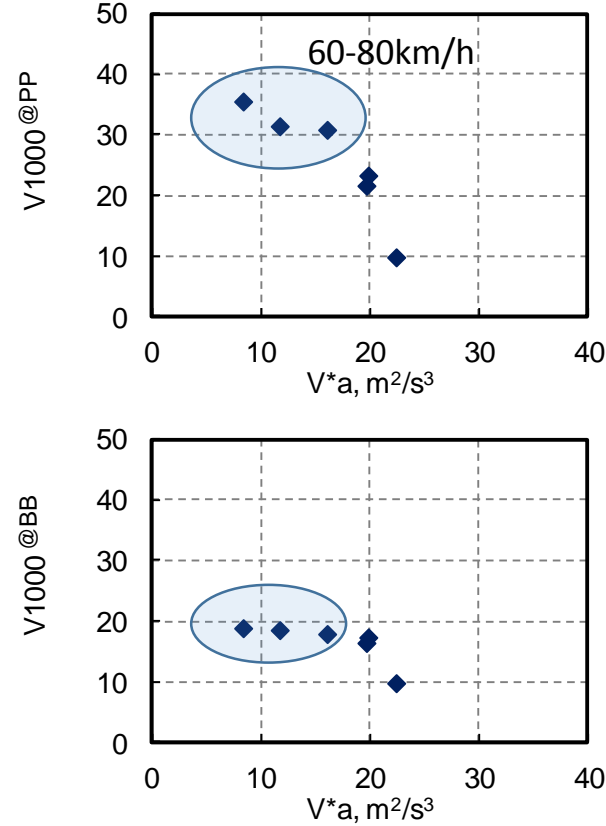
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Issue for non-locked gear ratio test



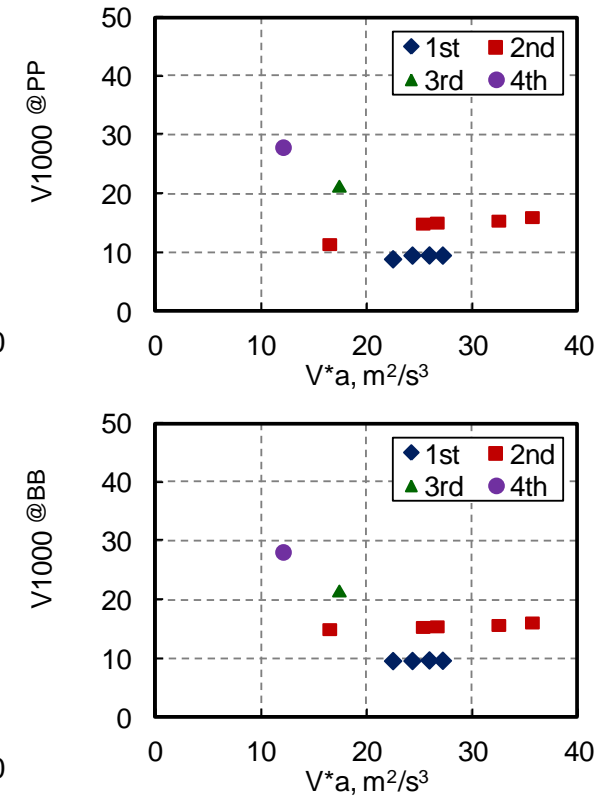
Gear ratio (V1000)

Non-locked gear test



Gear ratio is changing continuously from PP to BB at higher vehicle speed.

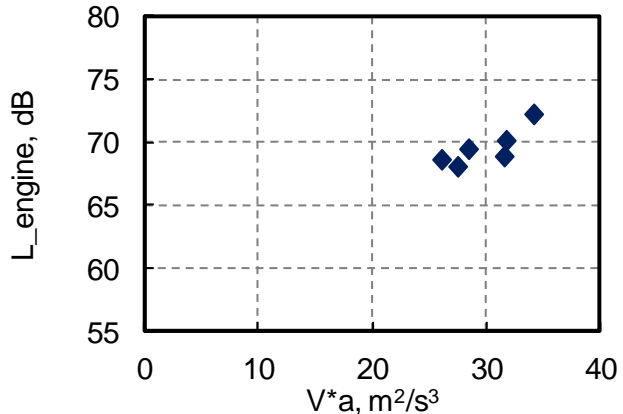
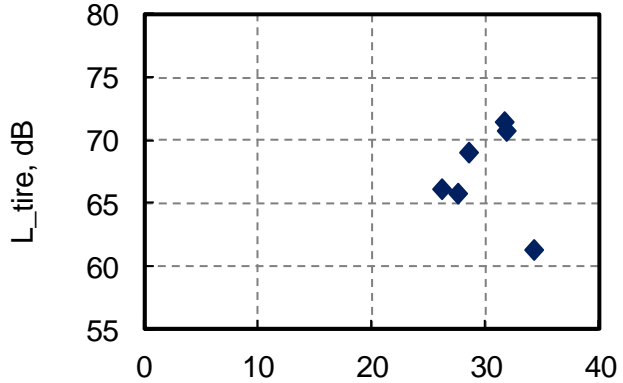
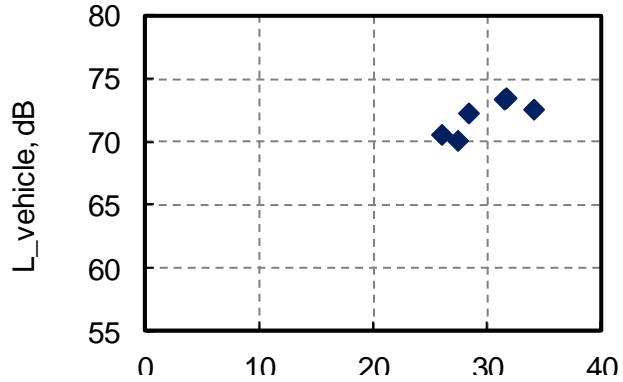
Locked gear test



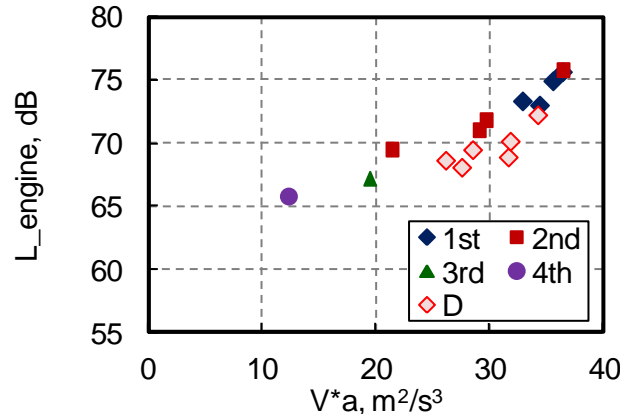
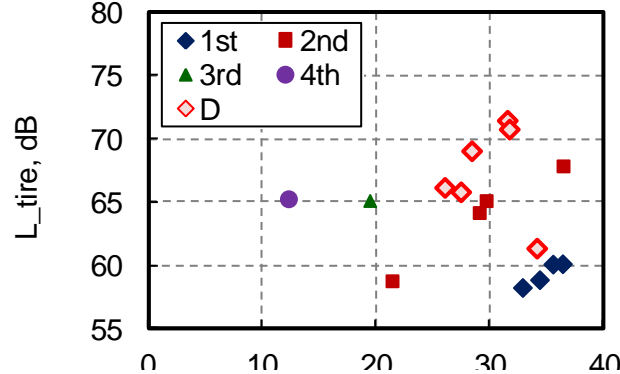
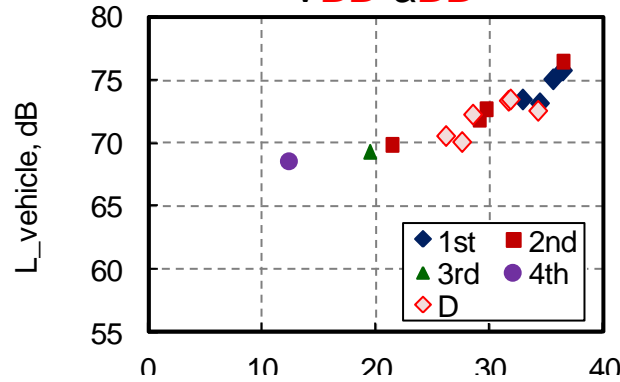
V1000 (gear ratio) at PP and BB almost same in locked gear test.

Idea of improvement for non-locked gear test

non-locked gear
 $V_{BB} * a_{BB}$



Locked & non-locked
 $V_{BB} * a_{BB}$

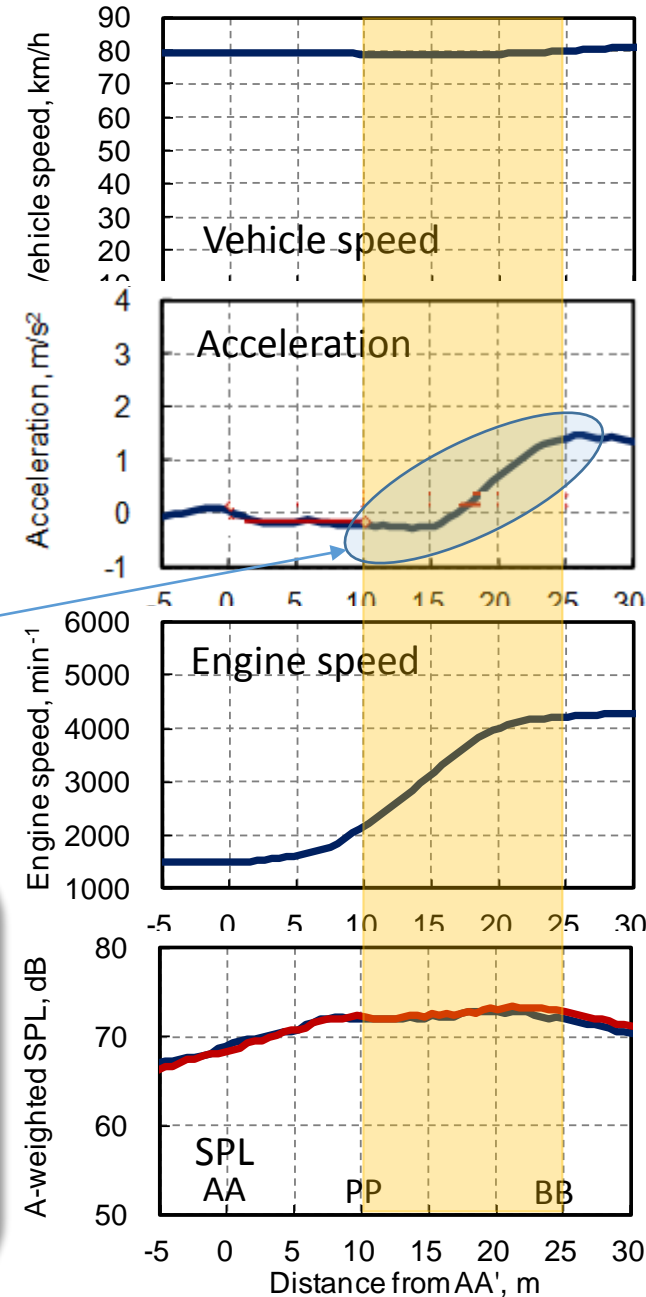


The result of locked and non locked gear test for $L_{vehicle}$ vs. $v * a$ are in same line by using v_{BB} and a_{BB} .

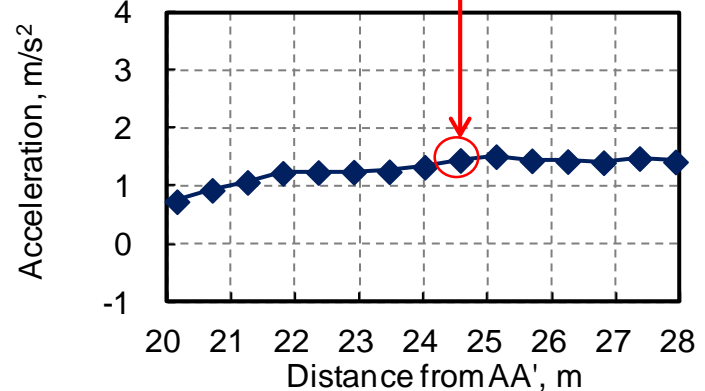
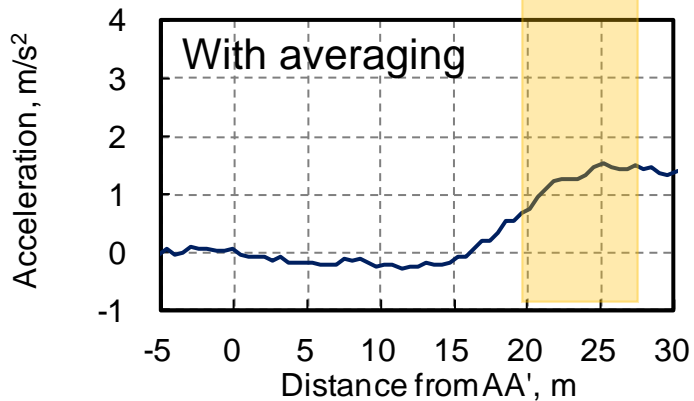
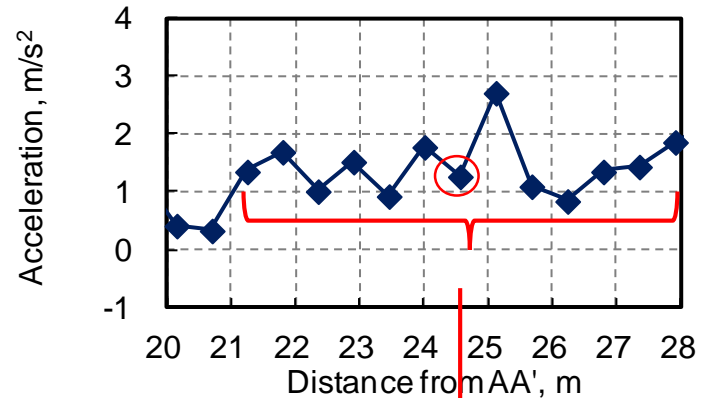
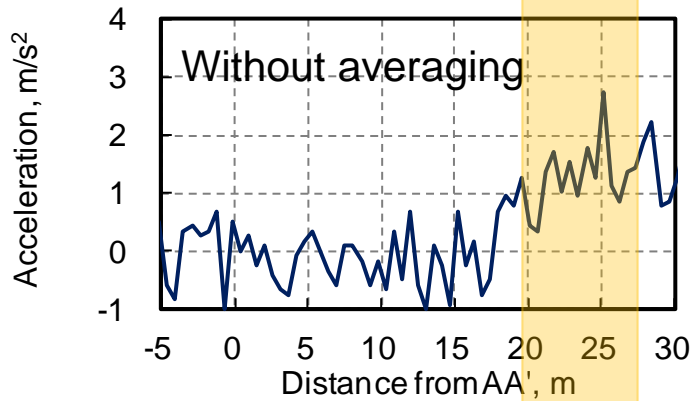
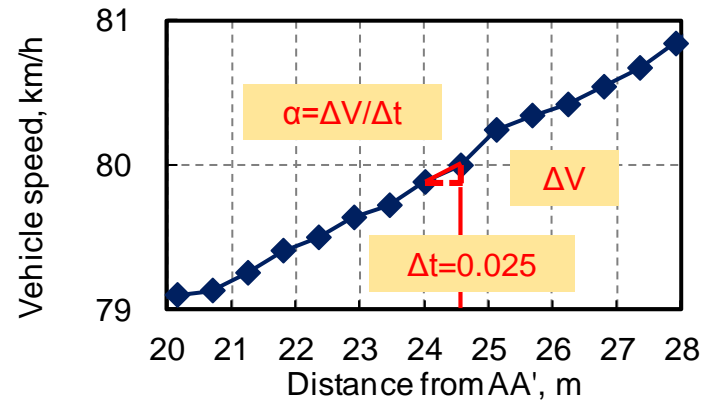
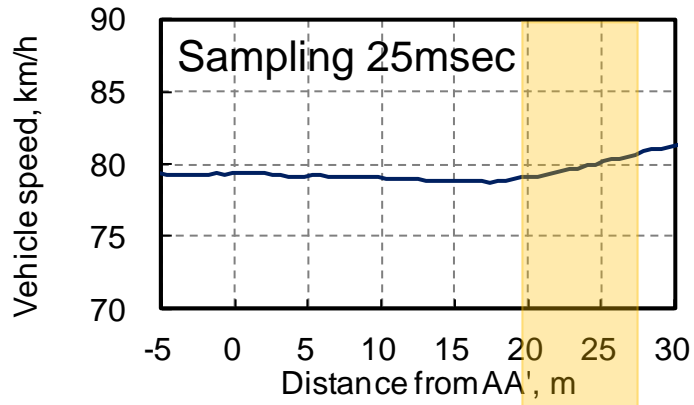
Acceleration rate is changing from PP to BB due to change of gear ratio continuously.

Disadvantage;
- Precise GPS vehicle speed instrument is needed.
- Measured acceleration is not stable.
➤ Further investigation is needed.

P4 non-locked



Process of calculation of acceleration



Measurement uncertainty

@BB	a [m/s ²]	V [km/h]	[rpm]
Run-1	1.91	55.0	3330
Run-2	1.84	54.8	3329
Run-3	1.82	55.3	3313
Run-4	1.79	55.5	3352
Δ Max-Mim.	0.12m/s ² 6.3%	0.7km/h 1.3%	39rpm 1.2%

Moving average

Averaged by 6 points before and after a center point (totally average of 13 data)

Summary

- $v * a$ can indicate vehicle performance.
However tyre noise influence and improving acceleration measurement should be considered.
 - Is higher gear (lower gear ratio) which has higher influence of tyre noise necessary in the scope?
Lower than gear i is in the current scope for ASEP.
- In case of ICE vehicle and WOT test, the results of $v * a$ is equivalent to that of engine speed base.
 - Is the other vehicle than ICE vehicle necessary?
 - Is the other condition than WOT necessary?
The scope of the current ASEP is ICE vehicle and WOT test.
- In case of non-locked gear ratio test, it is difficult to measure acceleration rate (a).
 - Vehicles with non-locked gear ratio in test have always ICE.
Engine speed base is easier for these cars at the moment.

Should be discussed the scope of ASEP first.

Driving scenario (route, driving condition, etc.)

ICE, the others

Electronic device controlled by software