



Car mechanic training course and acoustic technique education

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ABSTRACT

This report is showing of one example of the acoustic technique education adopted at the car mechanic training course. The author thinks that the anti-noise is important as one of the work of the car mechanic. In addition, the purpose of it is to urge understanding to a sound phenomenon of the car. For instance, it will lead to technological acquisition of the noise level measurement, frequency analysis, and the evaluation test when how to the frequency component with different exhaust noise to feel it is evaluated by the auditory sensation. This evaluation is an estimate of the magnitude to noisy feeling. The examination sound is an adjacent exhaust noise of the motorcycle and various reproduction sounds from the audio speaker. It is thought that making the student think about the current state and the content of the regulation of the automobile noise based on the above-mentioned experimental result can deepen understanding to the necessity of the noise control, and assumes it to be an outline of this education of giving the chance.

Keywords: Car maintenance, Diagnosis, Vibration phenomenon, auditory sensation

I-INCE Classification of Subjects Number: 610

1. INTRODUCTION

It is thought that the sound problem of the car is important partially of an educational subject of the car mechanic training course. For instance, a basic matter in the maintenance skill related to a car single purpose noise is hoped for as an educational content because the environmental impact evaluation of the road traffic noise is legally treated. As the malfunction diagnosis technology, sound information is one of the advanced maintenance technologies in the place of service. The author thinks that the anti-noise is as one of the work of the car mechanic from situation for the above-mentioned. By the way, the education subject is unprofessional for acoustic technique to the car mechanic training course. Therefore, discussion and thinking about is approach for effective anti-noise teaching to car mechanics.

2. ACOUSTIC TECHNIQUE CONCERNING CAR MAINTENANCE

2.1 Content concerning measuring technique

The car mechanic receives the skill guidance of an exhaust sound measurement with the noise level meter. And, these students' acquisition of the measuring method is more important than knowledge of details of the noise meter. However, because the annoyance changes greatly by remodeling the muffler, the mechanic should be able to judge the change. At this time, we should explain the frequency response of the noise meter, and make the student understand a basic matter of the A, C, Liner, etc.

The chance of knowing the frequency response of the auditory sensation because of ME (magnitude estimation) experiment is given to the student (1). The proving ground is almost the same environment as the car repairer training space. Next, the student conducts the evaluation experiment of "Noisiness" on a previous condition as the respondent. The sound source used for this experiment is an actual exhaust noise of the motorcycle and a reproduction sound caused by the speaker. In general, this evaluation is shown by an arbitrary numerical value. However, the evaluation by the numerical value of the sense might be difficult. This presumption is the one given to the author in the result of having executed a lot of experiments. The difficulty of the presentation of the judgment of

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the testee is reduced by applying this method. The student can easily confirm the relation between the amount of the auditory sensation of the person and the amount of the measurement of the sound through this experiment.

Via such an experiment, the student can easily confirm the relation between the amount of the auditory sensation of the person and the amount of the measurement of the sound. And this experiment is the one tested to cause the evaluation based on the feeling of exhaust sound of an actual motorcycle. Each volume of the generated sound with this exhaust sound and the speaker is a setting along the inclination of one straight line of the ME test result. Data concerning these examples is shown in fig.1, fig.2. The educative effect of this experiment is that the student becomes easy to understand to the characteristic A-frequency weighting network for the noise measurement caused by considering these results.

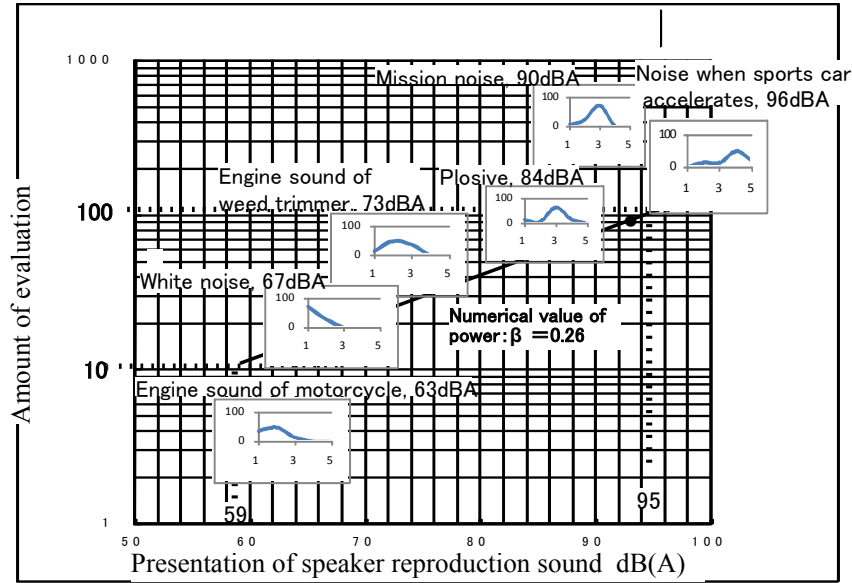


Figure 1 – Figure is an example of the data that 14 students obtained as a testee by the series of the noise evaluation experiment.

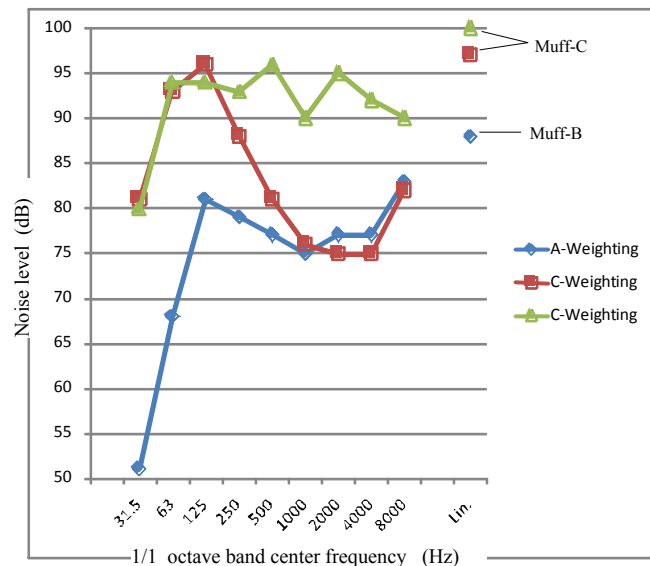


Figure 2 – Figure is the Instruction material: Exhaust sound characteristic that is silencer different from weighting of frequency

2.2 Diagnosis example by hammering test

In general, impact test with the test hammer is known for the diagnostics of the car. Impact test with a portable hammer might be one of the typical examples of the easiest diagnosis technology by acoustics.

In that case, the uncertainty is a cause that the difference of "Auditory sensation" given to the diagnosis causes it. If the simulation of the slapping sound is designed, it is effective for the student.

The tightening part forms a certain spring. Tightening with the bolt and the nut forms different spring steel that is because of tightness or looseness. It is assumed to be the one by the tightening part's forming the mechanical spring of tensile and compression, etc. Naturally, the hammer is the one composed as a mechanical mass of this vibrating system with one degree of freedom. This causes the state that the frequency of the vibration of normal mode is different according to strength of tightening. One of the phenomena that understand easily is contact time of the hammer and the shock part. And, the contact time changes according to strength of a different tightening. (Figure 3)

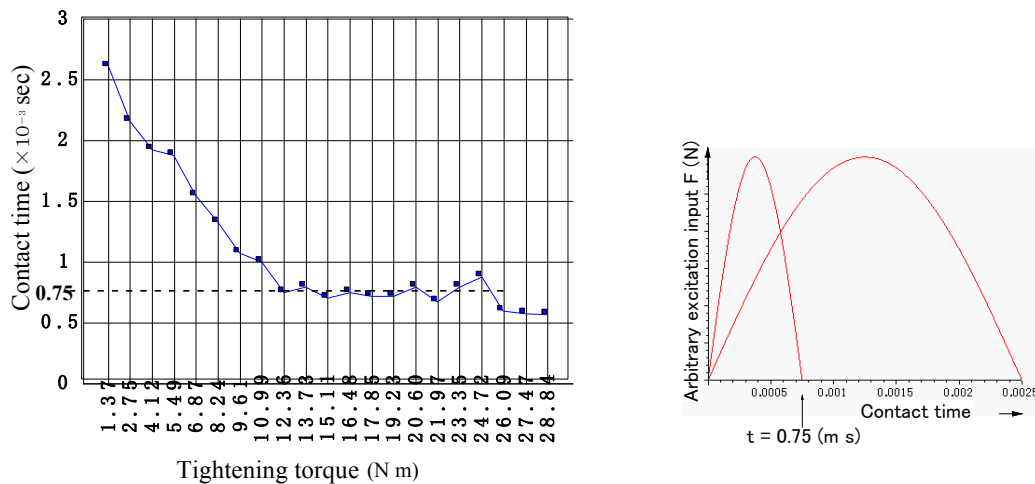
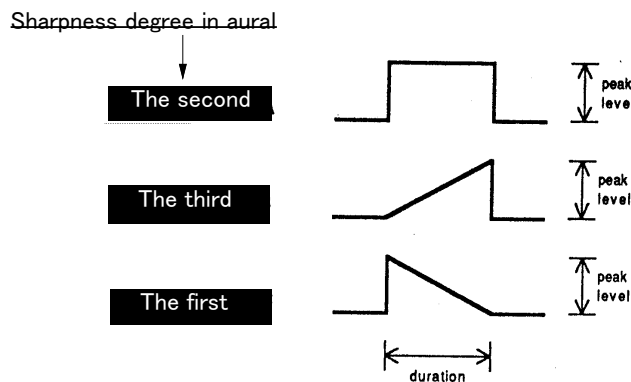


Figure 3 – Figure is the instruction material: Relation that contacts time of striking hammer by measurement data is different according to tightening torque.

The slapping sound of a different tightening appears to the aural judgment as a change in sharpness. However, for the judgment to require skilling is to be known well. For instance, the check is done about an important tightening part on the wheel nut and safety of the vehicle. The judgment by this slapping sound is one example content of the acoustic technique education concerning the tone.



Source: Sonoko Kuwano and others, Japanese acoustics association lecture thesis collection ,march, 1988.

Figure 4 – Figure is the relation between shape of waves and sharpness.

2.3 Combustion stroke cycle and fundamental frequency of engine

The combustion stroke cycle of the internal combustion engine of the car is two cycles or four cycles. This cycle is observed as an engine vibration. The item that influences the fundamental vibration is a number of cylinders, an engine speed, and a burning cycle. This vibration leads to the diagnosis of the fired condition of the engine. For example, strength of the vibration at that time decreases if the lack of the torque by the accidental fire is caused in a certain cylinder. This excitation brings it by the torque fluctuation of the internal combustion engine in the expansion stroke.

The frequency of vibration becomes the one proportional at the operation speed of the engine usually. However, the vibration frequency after the engine stops becomes a characteristic value formed by the mount system. The phenomenon of this damped oscillation is a characteristic value to which it is caused by the engine mount system. This damping characteristic is given by damping ratio, and it is requested by reading the change in the vibration amplitude. One of these damping characteristics is shown by the damping ratio. And, this damping ratio gives the loss factor derivation of the engine mount system.

In many cases, this is a content that becomes the problem of dynamics in the engineering education. But the content of a basic matter concerning these vibrations expects the diagnosis skill improvement of the maintenance engineer of the car by the acoustic technique ability.(Figure 5, 6)

Oscillatory waveform by normal burning cycle, Engine revolutions:800(rpm)

Oscillatory waveform of engine observed by having given accidental fire to one cylinder, Engine revolutions:800(rpm)

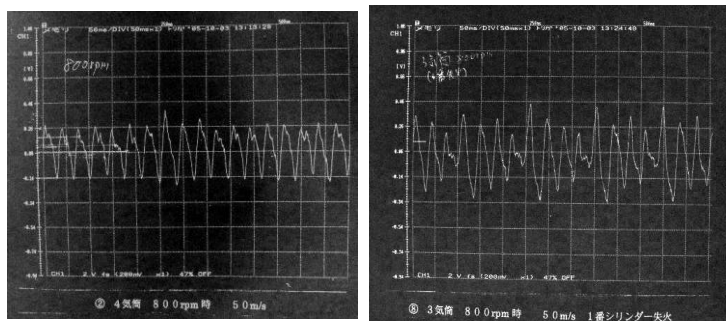


Figure 5 – Figure is an example of the data that oscillatory waveform of engine observed by different combustion condition

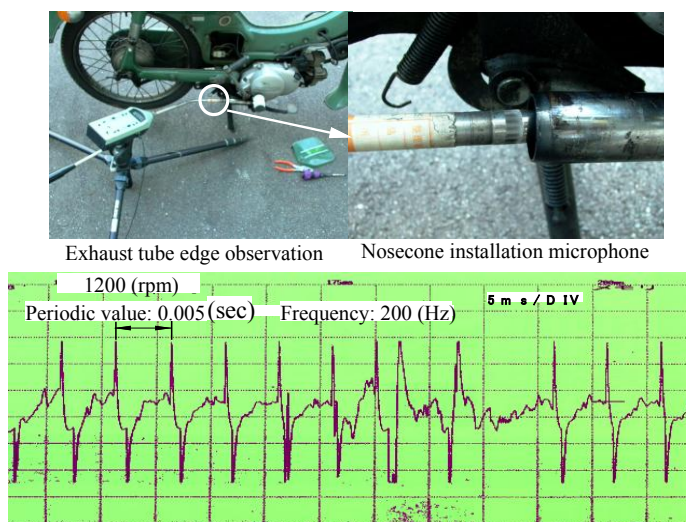


Figure 6 – Rotational frequency of engine observed by catching exhaust sound time-varying

2.4 Safety problem and auditory sensation

The warning signal sound is important in the safety confirmation. But, this expression might be wrong. For instance, it is a case with the confirmation according to the visual sensation. However, when the visual information is not obtained, information on aural becomes important. This situation is handled as assumption to the railroad crossing of the safety planning of Japan. One method is a video-assisted education for the driver of the car. The situation of the feature problem adopted with the video is "Because the sound of car audio was too large, the alarm cannot be heard." This situation is known by the press report concerning the collision of the train and the car of the railroad crossing. The traffic safety is very important in the standpoint of the car mechanic education. The problem is verification with respect to "An inaudibility of the alarm sound" for the inference based on one case with emergency preparedness. In other words, the problem reaches the verification concerning "It puts to obtain the alarm sound and is easy" for the inference based on the emergency preparedness of one case.

In the verification experiment here, the student is a testee. The student experiences the listening experiment, and studies the acoustic technique of the relation. The key word concerning the educational content that relates to this acoustic technique is "Listening limens of the alarm sound", "S/N" "Masking", and "Insertion loss of the body". The following experimental result is showing of the example of "Limens of the alarm sound listening". However, this experiment was prepared for the education of three high school students. The setting of the recognition level added to the limens is the one by the idea as the evaluation value that facilitates the understanding of S/N.

On the other hand, there is a different interpretation concerning the necessity of the alarm. And, it depends on the difference of the recognition of people. It is thought that the content of the description of "The alarm sound is important in the security verification" shown at the beginning of this item is recognition of general people to the alarm. If the necessity of the alarm sound is denied, the above-mentioned content becomes meaningless. And, the reason for this denial is the one based on the experience, and has the possibility that a lot of people have a similar idea. The author applied the following explanations about the grounds. The person has the characteristic of relying on the visual information at the early stage of the security verification. Naturally, the visual information is relied on at all chances of the decision making in daily life. However, auditory information is important as an inclusive function with the visual behavior. The situation of an intentional selection of the visual information or auditory information is clear according to the following cases. And, it can be thought that it is a judgment of the safe driving by its bringing the certain situation by the psychological condition. In addition, it seems that this problem is in the validity that person's potential common sense brings. It is necessary to correct this validity by the education, and to lead in an appropriate direction.

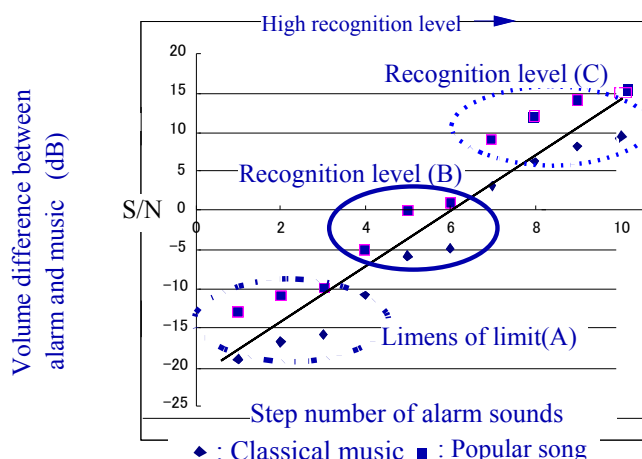


Figure 7 – For instance, when the person drives the car of the halt condition in the railroad crossing, the dependence for information on the sound is caused. Judgment (A) (B) (C) in figure is as follows content. (A): Limens of "Alarm sound listening limit" by influence that "Music of background" gives. (B) Judgment

assumed: influence that "Music of back ground" gives is "State of alarm sound's being able to listen music and simultaneously". (C)Judgment assumed, influence that "Music of back ground" gives is "State of being possible to listen to alarm sound more clearly than music"

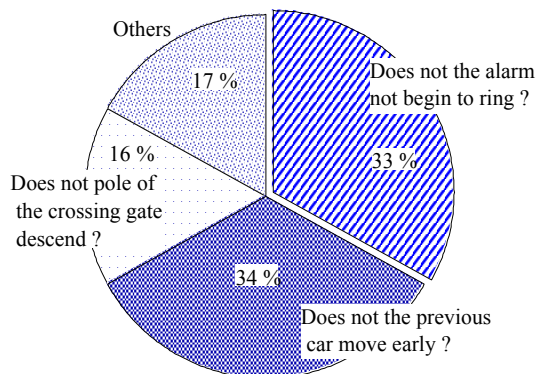


Figure 8 – For instance, when the person drives the car of the halt condition in the railroad crossing, the dependence for information on the sound is caused.

3. EDUCATIONAL CONSIDERATION TO AUTOMOBILE NOISE CONTROL

3.1 Young person's consciousness

Maintenance concerning the structure and the function of the car is executed according to Road Transportation Vehicle Law. However, the structure and the function enter the state that restricted content concerning the law is not satisfied if the user uses an unlawful muffler. In Japan, the campaign for the content that prohibits an unlawful structure modification was open to the public on the Internet. The reason for which the campaign is necessary depends on the noise of the two-wheeled vehicle that especially gives the social influence.

The author learnt the following facts in the questionnaire survey. A young person tends to assume that it likes motorcycle. And, a young person seemed to be enjoying the non-standard silencer by exchanging standard products. This tendency was shown by the questionnaire to the high school student.



Figure 9 – This is an example of the illegal muffler, from the homepage of the Ministry of Land, Infrastructure and Transport depending on June every year.

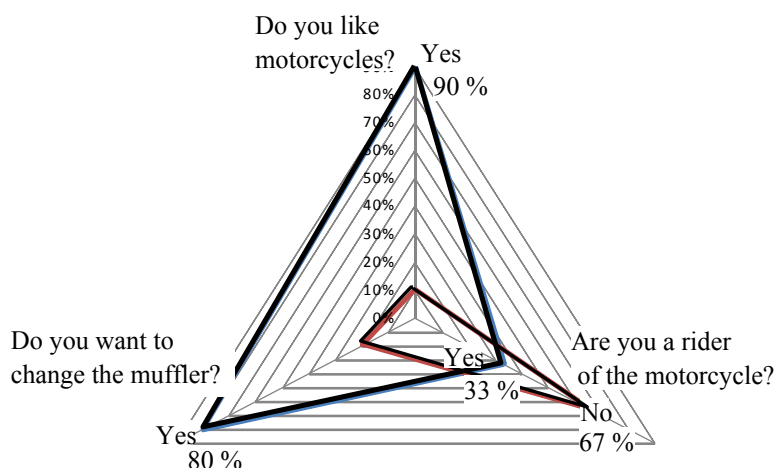


Figure 10 – Questionnaire finding: The high school student's consideration to motorcycle

3.2 Consideration of automobile noise to peculiar management

The instrument on board is observed by the monitor for the vehicle exhaust emission measures. It is OBD (On-Board Diagnosis) restriction that installing the device was legally obligated, and is operated it as an international standard. (Figure 11) However, the noise control system is not included in such a control item. Recently, the regulation in Japan is reviewed, and the effect is expected (2). (Figure 12) The application of legal management in the safety maintenance of the car has a part that is put on a new model and the renewal inspection, and is different respectively. A part different from the legislative response of a new model is that the mechanic answers user's requirement. When an unlawful remodeling is expected, it is mechanic's important role.

The method of the measurement in the inspection of the noise control system is established according to Road Transportation Vehicle Law. The calculation method for the forecast by the environmental impact assessment law can be used to explain the noise where a single vehicle runs by the constant rate. It should be thought that the chance of the acoustic technique use in the maintenance of the car increases. An educational content concerning the vibration and the noise is handled by the textbook of Japan at the first class mechanic training course over a lot of pages (3).

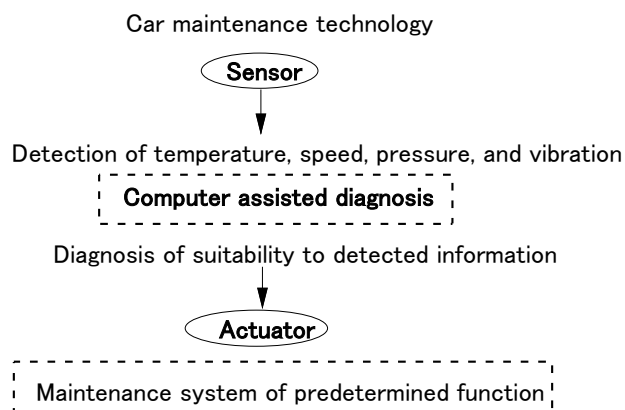


Figure 11 – Diagnostic system and safety maintenance technology of recent car

