International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 1, January - 2014

Reflection and Absorption of Sound on Rigid Pavement Samples in Different Environmental Condition

Pervez Alam[1], Naseem Akhter
[1]Assistant Professor Department of civil engineering, School of mathematical sciences and engineering, BGSB University Rajouri, J & K,

[2]Senior Scientist CSIR-CRRI, Mathura Road , New Delhi

Abstract

This research paper gives results on reflection and absorption of sound on different rigid pavement samples in different environmental conditions. The samples being placed in the oven at a temperature of 60 degree Celsius to represent a hot sunny day and to find the changes on the absorption and reflection of noise in these pavements. Also the samples being placed under water for almost 24 hours to represent a rainy day then finding the changes obtained for the absorption and reflection of noise in these pavements.

Key Word: *Reflection, Absorption, Rigid Pavement, Surface Impedance Meter*

1. Introduction

Sound is a form of energy which is emitted by a vibrating body and on reaching the ear causes the sensation of hearing through nerves. Sounds produced by all vibrating bodies are not audible because the audible frequency limit ranges from 20 HZ to 20,000 HZ.

In very simple terms, Noise is said to be any unwanted sound. Noise problem generally consists of three inter-related elements-the source from where noise generates the receiver who is going to receive noise and the transmission path from where noise will travel. This transmission path is usually the atmosphere through which the sound is propagated, but it can include the structural materials of any building containing the receiver.

Surface impedance meter is the instrument which can be use to know the reflection and absorption of sound through any surface. . The micro flown does only measure the source and not the background noises. It is true that very few studies have been done in the past to find the noise absorption and reflection on rigid pavement on different environmental condition.

In one of the study done by Naseem Akhtar et al (2012) discusses to find the reflection and absorption of sound in different types of pavements i.e. flexible and rigid pavement by surface impedance meter. In another study by Hirosawa, (2008) two-microphone method and two particle velocities method were compared in regard to in-situ measurement technique of normal absorption coefficient. In another study reported by Tijs and Bree, (2009) they used PU surface impedance method for measuring in situ both sound pressure and acoustic particle velocity, could be applied to measure the pavement surface impedance in a laboratory environment and also in outdoor environment.

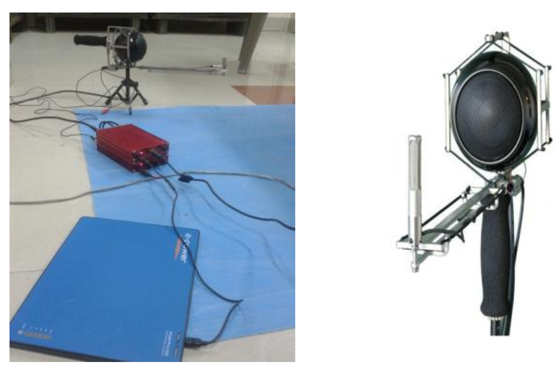

Figure.1- Surface impedance meter

2. Study area

For this study samples of rigid pavement were prepared in laboratory first and then tested under different environmental condition for absorption and reflection tests. For every measurement mode, a fixed frequency of sound (102 Hz to 104 Hz) was released by surface impedance meter when kept normal towards the sample surface in calibration mode for 6 second. After completion of calibration mode, the instrument was put in actual measurement mode and the sound is released till 6 second for absorption and reflection of sound in different rigid pavement samples. The different environmental condition for which absorption and reflection was measured are as follows

2.1 At room temperature (Normal condition)

The tests at normal temperature were conducted on rigid pavement samples under normal conditions. Samples made were tested for absorption and reflection without giving any pre-treatment i.e. at room temperature.

2.2 At temperature 600 C (Dry condition)

Secondly tests were conducted on rigid pavement samples in dry conditions i.e. samples were placed inside an oven pre-heated to 600 C for 24 hrs. The reason behind the samples been heated at 600 C was to see the noise behavior of rigid pavements in hot and arid regions, so that required modifications can be made to overcome noise problem in those regions.

2.3 In rainy season (Wet condition)

lastly tests were conducted on the rigid pavement samples in wet condition i.e. the samples were submerged in water inside the container for 24 hrs. and were taken out the next day, then kept in shade for 10 min. and then again sprinkled with water to check the behavior of samples in extremely rainy conditions.

3. Method

The sound source emits a transient sound wave which travels past the PU positioned to the surface under test and is reflected. The PU receives both the direct sound pressure wave travelling from the sound source to the surface under test and the sound pressure wave reflected by the surface. Micro flown Surface Impedance meter and software Si++ were used for this finding.

The method used to calculate the absorption and reflection of sound in rigid pavement samples under different conditions viz. normal, dry, wet, assumes that the material under test is exposed to a plane wave of normal incidence which gives rise to a reflected plane wave. The behavior of the samples was measured by software Si++ through different graph patterns and reflections due to difference in polar response of sound pressure and particle velocity. Sound pressure, it has an Omni-directional response and is a scalar, while Particle velocity is a vector and so is directional.

4. Results and discussions

4.1 Normal conditions

sample no	CEMENT KG	AGGREGATE KG	SAND KG	WATER KG	PLASTICIZER ml
cube	13.5	40.2	25.9	5.1	nil

Figure 2: shows rigid pavement sample at normal temperature

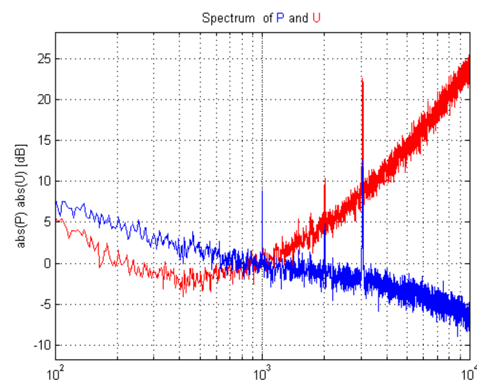

Figure 3: shows PU behavior at normal temperature

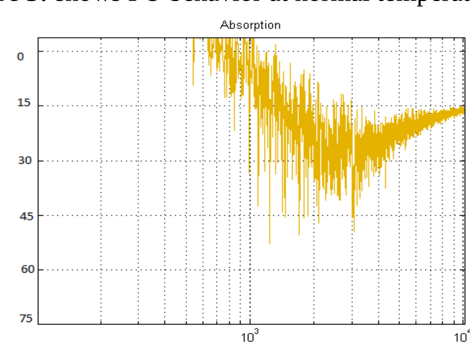

Figure 4: Varition in absorption

ISSN: 2278-0181
Vol. 3 Issue 1, January - 2014

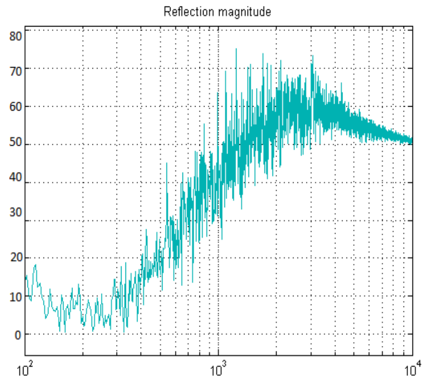

Figure 5: Variation in reflection

Figure 2 shows absorption measured by P (pressure sensor) and U (particle velocity sensor) at lower frequencies 10^2 to 10^3Hz in a rigid road pavement sample 1 under normal conditions is -1 dB and -2.5 dB respectively. But absorption at high frequencies 10^3 to 10^4 Hz is -7 dB and 25 dB respectively.

Figure 4 shows variation in absorption with change in frequency

Figure 5 shows small variation in reflection upto 10^3 Hz and large variation when frequency increases beyond 10^3 Hz.

4.2 Dry condition

sample no	CEMENT KG	AGGREGATE KG	SAND KG	WATER KG	PLASTICIZER ml
cube	13.5	40.2	25.9	5.1	nil

Figure 6: rigid pavement sample in dry condition

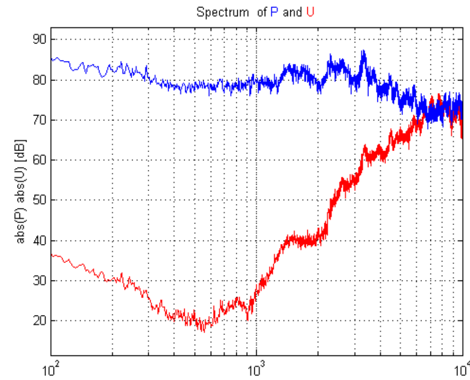

Figure 7. PU behavior in dry condition

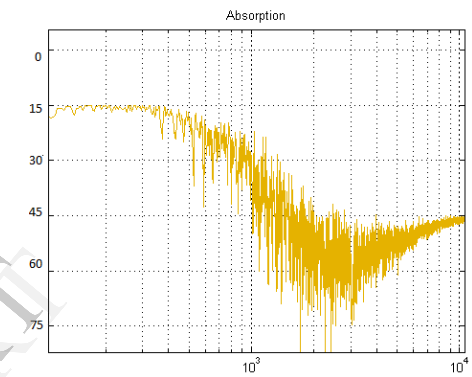

Figure.8 Shows absorption pattern

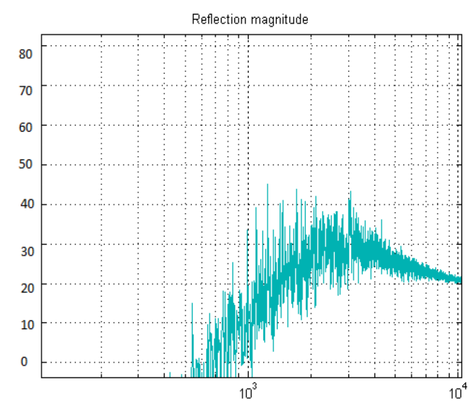

Figure 9. Reflection pattern in dry condition

Figure.7 shows absorption measured by P (pressure sensor) and U (particle velocity sensor) at lower frequencies 10^2 to 10^3Hz in a rigid road pavement sample under dry conditions is 80 dB and 20 dB

respectively. But absorption at high frequencies 10^3 to 10^4 Hz is 75 dB and 70 dB respectively.
Figure 8 shows opposite behavior as that in reflection with change in frequency. Figure 9 shows very small reflection upto 10^3 Hz and large increase in reflection when frequency increases beyond 10^3 Hz.

4.3 Wet Condition

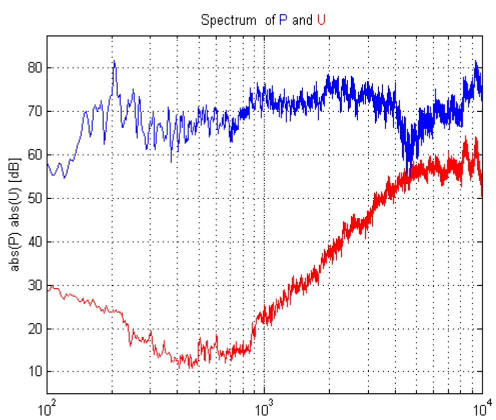

Figure10. PU behavior in wet condition

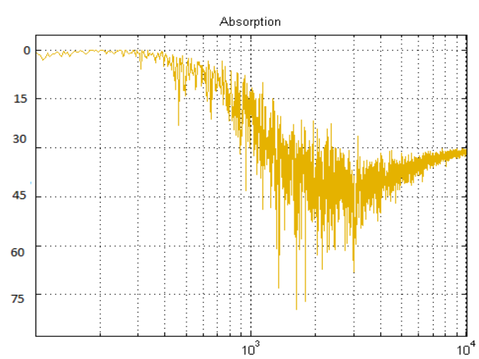

Figure11. Shows absorption pattern

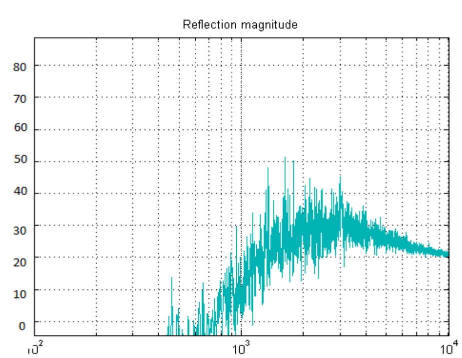

Figure12. shows reflection pattern in wet condition

Figure 10 shows absorption measured by P (pressure sensor) and U (particle velocity sensor) at lower frequencies 102 to 103Hz in a rigid road pavement sample under dry conditions is 60 dB and 12 dB respectively. But absorption at high frequencies 103 to 104 Hz is 55 dB and 60 dB respectively.
Figure.4 shows opposite behavior as that in reflection with change in frequency.
Figure.5 shows very small reflection upto 103 Hz and large increase in reflection when frequency increases beyond 103 Hz.

5. Discussion on results

It is evident from the study of graphs shown above that the rigid pavement samples when kept for incubation at 600 C inside an oven showed more absorption characteristics followed by the samples when kept in wet conditions submerged in a container filled with water and by samples in normal conditions respectively. Also reflection was seen to follow the opposite trend of that of absorption. Noise absorption measured by P (pressure-sensor) & U (particle velocity-sensor) by rigid samples of different grades did not showed much deviation when compared to each other but deviation was of different magnitude barring the change in conditions viz. normal, dry and wet. Pressure- sensor shows less variation in both types of pavements, while particle velocity sensor shows downward trend till 103 (Hz) frequencies and upward trend till 104 (Hz) frequencies. Hence, particle velocity sensor U, gives better result as compared to pressure- sensor P.

6. Conclusion

It is clear from the study that Rigid pavements samples when tested under different conditions viz. normal, dry and wet shows that sound absorption is more in dry conditions followed by wet condition and lastly in normal conditions. Reflection characteristics were seen to follow opposite trend than that of absorption i.e. more reflection was seen in rigid pavement samples under normal conditions. Pressure sensor shows less variation in both types of pavements, while particle velocity sensor shows downward trend till 103 (Hz) frequencies and upward trend till 104 (Hz) frequencies. Hence, particle velocity sensor U, gives better result as compared to pressure- sensor P.

References

[1] E Tijs and HE de Bree (2009). An in situ method to measure the acoustic absorption of roads whilst driving. *NAG/DAGA International Conference on Acoustic, Rotterdam, March 2009*.

[2] Emiel Tijs (2010).High resolution absorption mapping with a pu surface impedance method. *Baltimore Maryland NOISE-CONFERENCE 2010, April 19-21*.

[3] Akhtar et al. (2012). Reflection and absorption of sound, in different types of road surface – using microflown surface impedance meter. *International Journal of Applied Engineering and TechnologyISSN: 2277-212X (Online) 2012 Vol. 2 (2) April-June, pp.49-5l.*