inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 0.0

AN EXPERIMENTAL STUDY ON GROUND VIBRATION ISOLATION USING A MODEL (SECOND REPORT)

Y. Kani*, K. Hayakawa, **, Y. Maekawa**

* Nippon Concrete Industries Co., Ltd tel:, 4-2-12 Meieki Nakamura-Ku, 450-0002, Nagoya, Japan

** Ritsumeikan University, 1-1-1 Noji-Higashi, Kusatsu, 525-8577, Shiga, Japan

Tel.: 81-52-581-0666 / Fax: 81-52-641-2530 / Email: kani@star.ncic.co.jp

Keywords:

ABSTRACT
Attempts were made in this study to establish mechanism about ground vibration isolation through experiments using model barriers. Effects were identified of the diameter of the hollows, as well as the distance between two solid parts of such barriers on their performances. Their effectiveness was found to rapidly improve with an increase in the hollow diameter. Two non-dimensional parameters were identified to provide variables governing the performance of a barrier composed of hollow PCwall piles.

1 - INTRODUCTION
Barriers built with hollow PC wall piles have been proposed to isolate ground vibration in its path of propagation, their effectiveness have been recognised through a number of past studies [1]. The mechanism through which these barriers isolate ground vibration, however, has not been fully understood yet because of certain limitations imposed on field studies. Attempts were made in this study to establish such mechanism through experiments using model barriers.

2 - EXPERIMENTAL SET-UP
Fig. 1 shows the experimental set-up. A steel box, 100 cm long, 60 cm wide and 60 cm depth, with its bottom lined with an 8 cm thick urethane sheet to prevent vibration wave from reflecting from side wall and bottom was filled with a dry sand to a depth of 40 cm to make up the model ground.
Two different methods were adopted to produce ground vibration in vertical direction; one with impact by a 156 gr weight freely dropping from a height of 7 cm, and the other by using an electric generator (Model-PET-OA, made by IMV) capable of creating a vibration at a constant acceleration. With this latter, tests were conducted with 6 different frequencies; 50,75, 100, 150, 200, and 300 Hz.
Five different model barriers were tested in the experiment using the dead-weight to generate a vibration by impact; one made of solid concrete piles, three, each composed of different PC wall piles differing in hollow diameter in three steps (3 cm, 6 cm and 9 cm), and finally a steel plate. For those using the electric generator, six different model barriers tested, one composed of solid piles, five each of which was composed of different model piles differing in hollow diameter in five steps (2 cm, 4 cm, 6 cm, 8cm and 10 cm). For further information on the experiments, reference can be made of the reports previously published [2].

3 - RESULTS AND OBSERVATIONS

3.1 - Results from the impact excitation tests
Shown in the left side diagram in Fig. 2 is the vibration acceleration level (recorded at the position No. 2 located at a distance 20 cm behind) each of the barriers tested.
Same vibration acceleration level is also shown of the data registered at the same position without a barrier for comparison. The right side diagram in Fig. 2 shows the reduction in vibration level by each barrier tested.
From the data taken through the tests, it can be concluded that:

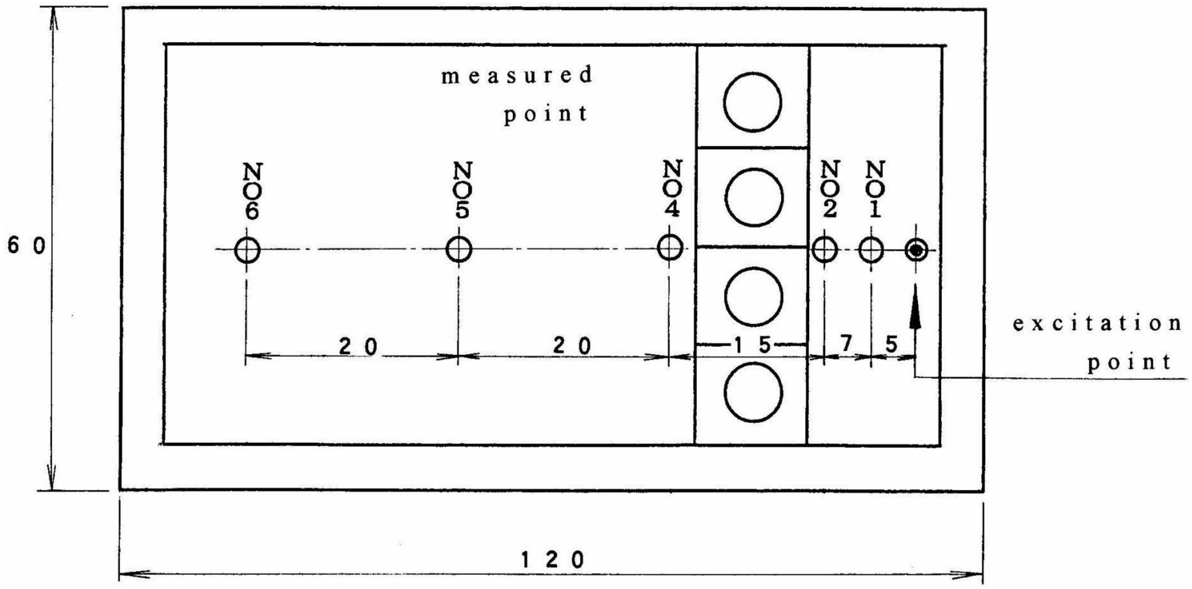
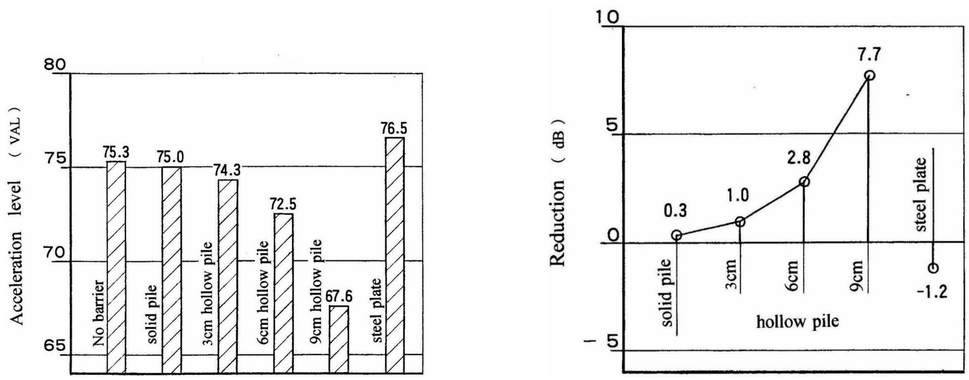


Figure 1: Experimental set-up.



(a): Level of acceleration. **(b):** Reduction in vibration level.
Figure 2: Relative performances of different barriers.

- as measured at a point just behind them, the solid pile barrier and the steel plate are much less effective to isolate vibration than any of those made of hollow piles,
- while the effects of the former are negligible, those of the barriers made of hollow piles improve with an increase in the diameter of their hollows.

3.2 - Results from stationary excitation tests

Fig. 3 indicates the acceleration measured at Point No. 4 just behind each of the six different barriers. Shown as being typical are the data taken at two different frequencies; 50 Hz and 150 Hz. From these data, it can be appreciated that: (1) the diameter of the hollow has little effect on the performances of the barriers to shut off vibration at 50 Hz, (2) at 150 Hz (and higher frequencies), the barriers are noticeably effective. Their performances, however, does not necessarily improve with an increase in hollow diameter.

4 - ANALYSIS BY TAKING INTO ACCOUNT WAVE LENGTH

Just determining how the performances of different barriers, each composed of a number of similar hollow piles, are affected by the diameter of their hollows does not appear to be very helpful. In order to compare, by using a common criterion, the results of the experiment such as this with those taken at actual construction sites, it was decided to use a non-dimensional parameter D/λ (the quotient between hollow diameter and the surface wave length) to represent the relative size of the hollow and a variable called amplitude reduction factor to identify the performance of a given barrier.

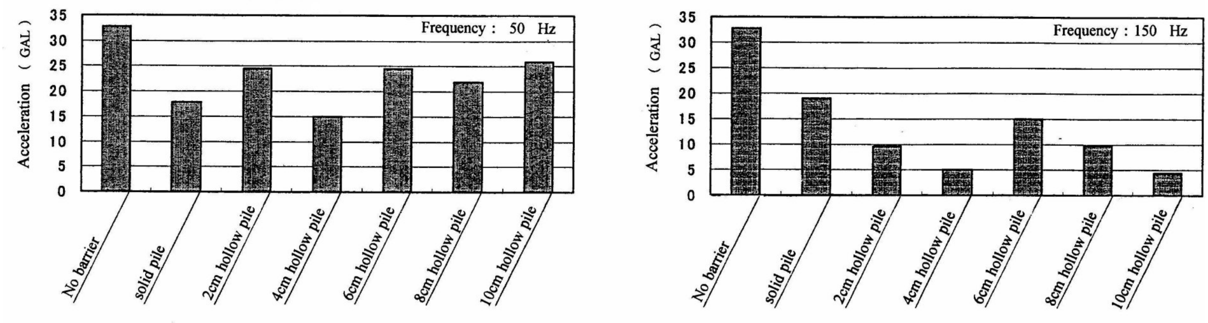


Figure 3: Performances of different barriers under constant acceleration tests.

The amplitude reduction factor, hereinafter referred to as ARF, is expressed as follows:

$$\text{ARF}=\frac{\text{Acceleration of the ground vibration registered with a barrier}}{\text{Acceleration of the ground vibration registered without a barrier}} \tag{1}$$

The data on acceleration taken through the constant acceleration tests were converted into ARF and the results were plotted in Fig. 4 against the parameter D/ λ. For the purpose, the speed at which the surface wave traveled was assumed to be 67 m/sec as was recorded in the tests of stationary wave.
It can be seen that, albeit with a large scatter, the data are mostly located between the two curves shown in the diagram, and that the ARF is generally seen to decrease with an increase in the parameter D/ λ, suggesting that the hollow diameter has a large effect on the performance of a barrier. It can further be noted that, an increase of the order of 0.2 in parameter D/ λ is needed to reduce the amplitude by half.

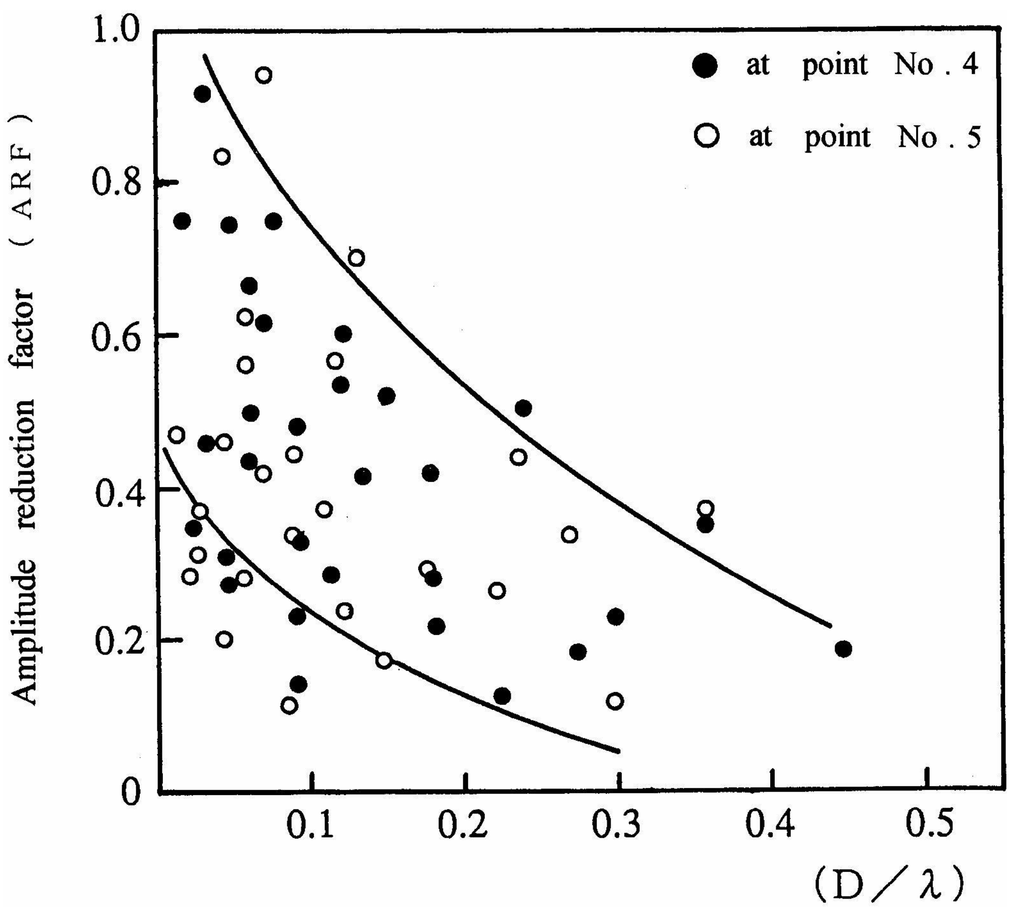


Figure 4: Relationship between amplitude reduction factor and parameter (D/λ).

Fig. 5 shows the relationship between yet two different variables; the one called the "vibration reduction effect" is equal to the difference between 1 and the amplitude reduction factor (1-ARF). and the other is another non-dimensional parameter which is the quotient between the difference between the distance S between two solid parts of a given barrier and the diameter D of the hollow of the piles composing the barrier. It can be seen that not only the hollow diameter but the distance between two solid parts of a barrier provides a factor governing its performance.

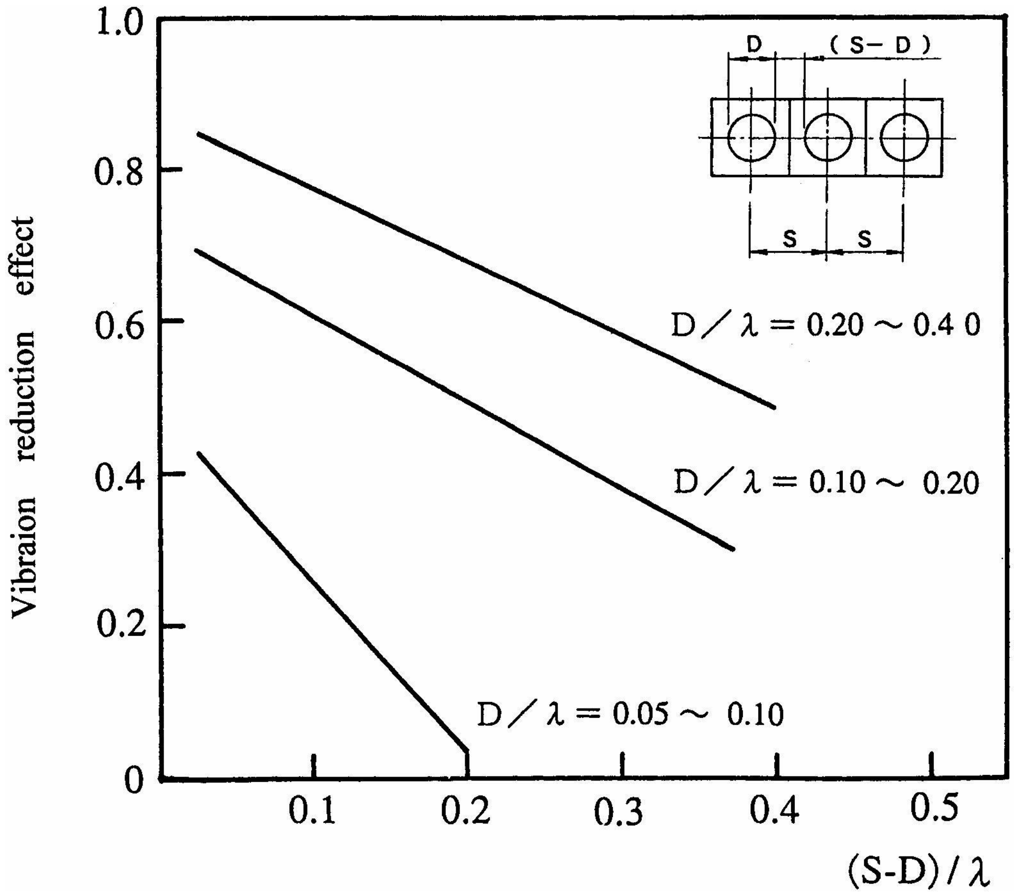


Figure 5: Relationship between vibration reduction effect and parameter (S-D)/λ.

5 - CONCLUSIONS

Experimental studies were conducted on model barriers to determine the performances of vibration barriers composed of hollow PC wall piles. Effects were identified of the diameter of the hollows, as well as the distance between two solid parts of such barriers on their performances. Their effectiveness was found to rapidly improve with an increase in the hollow diameter. Two non-dimensional parameters were identified to provide variables governing the performance of a barrier composed of hollow PC piles.

REFERENCES

1. **Matsubar, N, Kani, Y., Hayakawa, K., Woods, R. D.**, Isolation Effects of ground vibration due to PC wall piles on several sites, In *Seco Pint/Second International Conference on Earthquake Geotechnical Engineering*, pp. 427-432, 1999

2. **Hayakawa, K., Kani, Y., Matsubar, N., Koshimura, Y.**, An experimental study on ground vibration isolation using a model, In *Inter-Noise99*, pp. 871-874, 1999