III－276 MEASUREMENT OF WATER PRESSURE WAVE DUE TO IMPACT FORCE

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Introduction

During dynamic compaction or pile driving, the pore pressure in the soil will change, especially in saturated loose sands. In general, the sampling frequency for measurement of the motion of a body is an important parameter. This parameter is dependent on the sensitivity of the sensors and the capacity of memory of data loggers. In order to measure the pore water pressure change in saturated loose sands, a series of tests were undertaken, using pore pressure transducers pre-installed at different levels into a cylindrical sample.

The response of the pore pressure transducers were calibrated in water, in order to check their response during pressure raising. The results from these tests are presented in this paper along with the results from impact force tests performed on saturated loose sands.

Response of pore pressure transducer

The response of pore pressure transducers was checked in a cylindrical container 400 mm in diameter by 800 mm height (Figure 1), filled with water at 350 mm height. The transducers, which were fully de-aired, were located at different levels, 130 mm (a), 210 mm (b) from top of water. The container was placed in an Instron loading machine. An initial pressure of 20 kPa was applied on top of the sample. After equilibrium reached, a pressure increment of 150 kPa was instantaneously applied. The load and pore pressures were recorded using a PC with a Bakker card sampling at a frequency of 1 kHz. The maximum load was reached after about 0.5 second, which corresponded to the loading rate limit of the loading machine.

Figure 2 shows the applied pressure (p), calculated as the applied load divided by the area

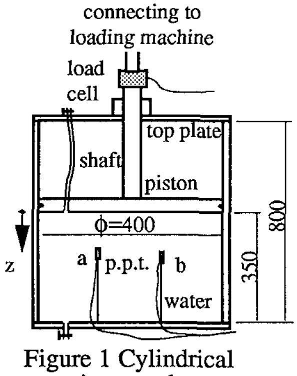

Figure 1 Cylindrical container used tests

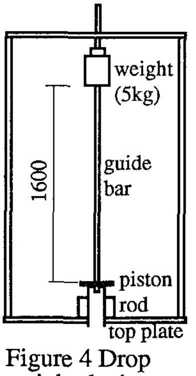

Figure 4 Drop weight device

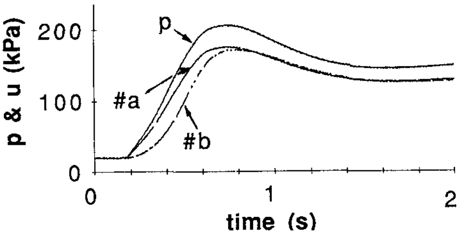

Figure 2 Time records of pore pressure

of contact piston/water, and the measured pore pressure for both transducers (#a and #b) versus the time. The curves show a similar trace for both transducers, with a delay of #b in compared with #a. The final pressure measured is almost the same for both and is about 85 % of the applied pressure.

The increment of the measured pore pressure normalised by the increment of applied pressure is plotted against the time, and is shown in Figure 3. For the pore pressure transducer #a, the time lag is very small (about 5 ms), while the time lag for the transducer #b is approximately 0.5 second. It can be observed that the response of #a is approximately linear, while a non-linear response of #b is noted.

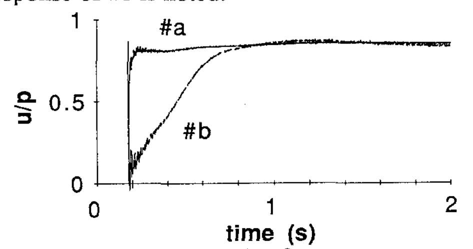

Figure 3 Time records of pressure response

It can be suggested that even if the sensors were the same kind, the individual characteristics will be different. Therefore, it is important to use a quick sampling rate to calibrate their responses.

Pore pressure measurement in saturated loose sands

One-dimensional impact tests were performed by dropping a 5 kg weight from a height of 1.6 m (figure 4), on to the top of the piston shaft illustrated in Figure 1. Pore pressure changes at different levels in the cylindrical container were measured.

Initially, the container was filled with water, in order to calibrate the response of the transducers. Four sensors were placed at 20 mm (a), 130 mm (b), 210 mm (c) and 270 mm (d) below the piston/water interface. Figure 5 shows

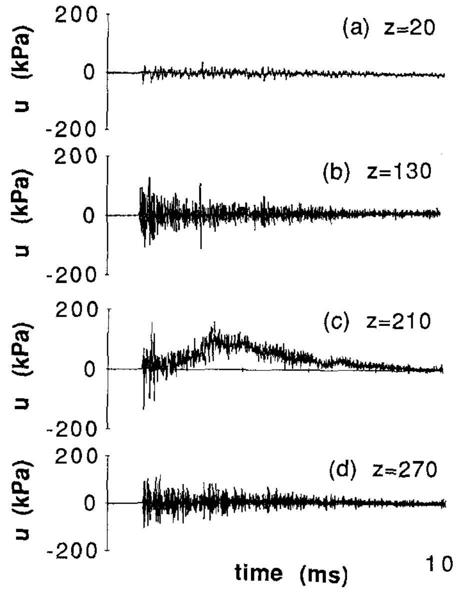

Figure 5 Time records of water pressure in water due to impact

the plot of pore pressure versus the time, for a sampling frequency of 200 kHz. At the two upper levels ((a) and (b)), no change of the mean water pressure is observed. At the two lower levels ((c) and (d)), an increase followed by a decrease of the mean water pressure is observed, and is more pronounced for (c). The first rising part in the curves (Figure 5 (c) and (d)) are thought to be equivalent to a delayed response of the pore pressure transducers.

Even if the measured pore pressures are not realistic, the time at which the first impulse occurred is correct. Figure 6 shows the plot of the water pressure velocity versus the sampling frequency. The curve shows an increase of the velocity with the frequency, and for about 10 kHz the measured velocity is identical to the theoretical velocity (about 1550 m/s). The measurement error of the water wave velocity is large for low frequency or large sampling interval. The same observation were noted for a large model (Δh=1m).

The same one-dimensional tests were performed on saturated loose sands (e=0.65), with the same set up and sampling frequency as

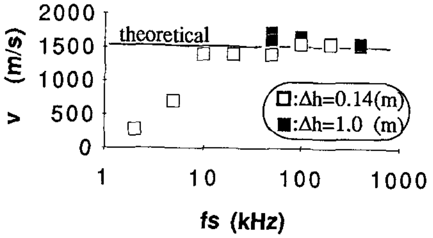

Figure 6 Sampling frequency versus water pressure velocity

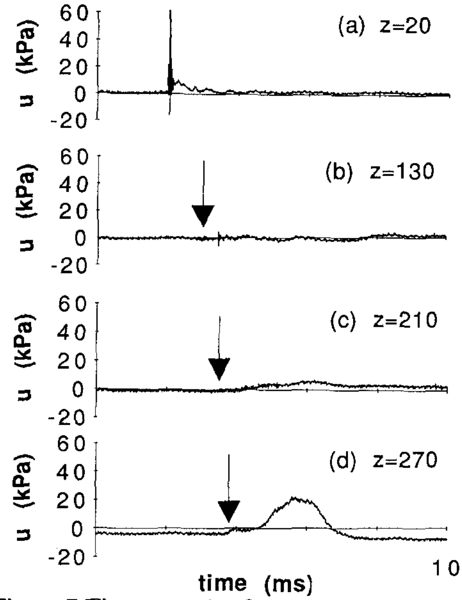

Figure 7 Time records of pore pressure in saturated loose sand due to impcat

for the previous tests. The shape of the curves obtained in saturated loose sands (Figure 7) are different than with water (Figure 5). The curves are more smooth and the magnitude of pore pressure are more pronounced. At the upper point (Figure 7(a)), a pore pressure spike was measured. At the others, pore pressures varied smoothly. The maximum value (30 kPa) at the bottom trasducer was larger than that (8 kPa) at thetransducer above, while in the water test, the opposite occurred. The magnitude of pore pressures measured for saturated loose sands were smaller than those for the water except for the upper part of the samples. It is probably caused by an energy loss due to micro-movement of soil particles.

The water pressure velocity calculated from the time at the marked arrows in Figure 7, is approximately 150 m/s. This value was very small, and disagreed with the theoretical value by Ishihara (1971). This reason is still not clear.

Summary

1. For quick sampling tests, it is important to calibrate the response of sensors.
2. Pore pressure changes in saturated loose sands due to impact are deferent to those in water
3. The sampling frequency must be selected according to the rate of loading and the response of sensors.

Reference

Ishihara K. (1971); On the longitudinal wave velocity and Poisson's ratio in saturated soils, Proc. of 4th Asian Regional Conference on SMFE, Vol. 1, pp197-201