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EXPERIMENTAL ANALYSIS OF GROUND VIBRATION DUE TO TAPERED PILES DRIVING

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Pile driving is one of the conventional methods for the construction of deep foundations. Pre-cast steel or concrete piles with different geometries are penetrated to the specified depth by appropriate tools such as free-fall hammers or diesel pile driver and then loaded. Use of this method may create some different problems in environmental cycle such as noise, air pollution and ground vibration. The ground vibration induced by hammer impact is too important to consider during pile driving and it may cause serious effects on adjacent area. Despite of difficulty to estimate and mitigate the vibrations, the determination of driving resistance provides important information by pile penetration.

In this paper, the drivability tapered and cylindrical piles and the ground vibrations induced in the adjacent area of them are investigated by experimental analysis and field tests.

The numerical analysis of pile driving for tapered piles was presented by Ghazavi and Tavasoli (2012). A three-dimensional finite difference analysis for taper angle and geometry effects has been used on pile driving response of tapered piles. Generally speaking, tapered and partially tapered piles offer better drivability performance than cylindrical piles of the same volume and length. A soil-pile system has been simulated for pile driving phenomenon using a three dimensional model for non-uniform cross section piles using FLAC3D.

The main criterion to evaluate area vibrations during driving is peak particle velocity when waves move in the soil. Two piles with different geometries are considered for experimental tests. All piles have identical length of Lp= 250 cm and volume. Pile T is fully tapered with 212 mm top diameter and 115 mm toe diameter. Pile C is cylindrical pile with 162 mm diameter. They were made of steel with 5mm thickness. The single acting hammer with a 300 kg weight falling from a height of 1m is used to install all piles to the embedded length of 0.5 m to 2 m, as shown in Fig. 1. The field was located in Vardavard-Tehran. The site soil has a maximum mass density of g_d, max=2.16 kg/cm^3 and relative density of about 93%. To record induced pile and soil velocity during driving, different instruments were used: (a) the pile driving analyzer (PDA) with two accelerometers and strain transducers, and (b) Seistronix RAS24 seismograph and 4*100 Hz geophone devices. PDA sensors were installed 34 cm below of piles head. Geophones arrays, as shown in Figure 2, are the linear radial with distances of 8, 12 and 16 times of pile diameter. After analyzing the data recorded by the devices and the processing and filtering waves, wave-induced velocity will be obtained. The signal matching result of pile-C driving is illustrated in Fig. 3. As observed, the best matching is concluded between the force and Z.V diagram under per hammer blow, which Z=E.A/C is impedance coefficient of pile and V is pile top velocity.

Figure 1. Pile driving system

Figure 2. Geophones arrays

By comparing the period of PPV diagrams because of Pile-C and Pile-T driving, the frequency ranges were calculated between 50 and 55 Hz. The average wave speed in the ground was also measured 346.26 and 425.01 m/s during the driving of Pile-C and pile-T. The effect of source shape is seen obviously in these cases. The results of wave propagation and the induced velocity in the soil at different distances from the pile-C are shown in Figure 4. With comprising PPV in different time, it is concluded that the vibration amplitude and radius decrease with increasing the distance from the pile. Due to material damping in the soil and pile and radiation damping, the propagated waves are dissipated.

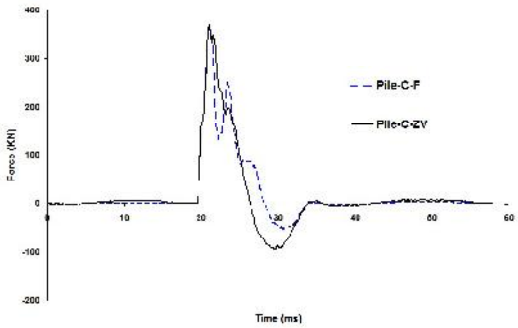

Figure 3. Signal matching of pile-C

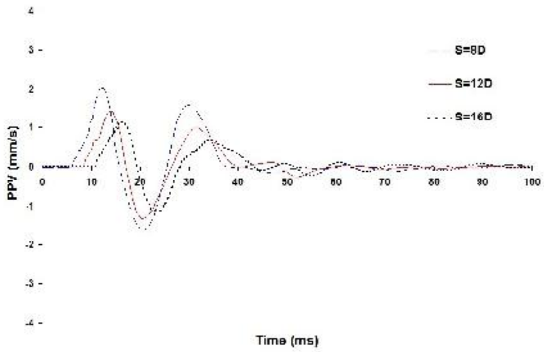

Figure 4. Soil velocity for pile-C driving

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