O12-4 VIBREX PILE DRIVING VIBRATION MONITORING AND IMPACT ON SETTLEMENTS OF BUILDINGS, ISTANBUL

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Vibrations caused by industrial activities (such as, piling, blasting, traffic, wind energy generations, vibrating machinery etc.) are harmful for buildings structures and for human held. Therefore there exist some standards and regulations for permissible distance between source and receiver and for resulted ground velocity, acceleration and the displacement for environmental protection.

In this study, we investigated role of existing building settlements of vibrex pile driving in old river sediments in Anatolian side of Istanbul. To do that we utilized vibration monitoring seismic, refraction, electrical soundings, and drillings and earthquake analysis. Study area is 5 000 m^2 which is surrounded with 5 to 8 floor buildings class III. Diameter of a vibrex pile is 0.45 cm, length is about 20 meters, piling interval is 3.3 meter, SPT (N_{30}) 0 to 5 blows, for the DELMAG D36-13 piling machine, strike frequency 37 to 53 blow per minute, hydrolic hammer weight is 8050 kg, stroke power is 6 000 to 12 000 kg. Poisson's modulus of soil is 0.42 and elasticity modulus are as such, shear g=2.6 10^7, E=7.28 kg/m^2 and m_v=0.6 10^8 cm^2/kg.

In such area, piles should be driven at a distance of $\tau < [\tau]$ with obligatory observation of deformations and settlements of buildings and structures.

On the basis of the examinations results determine the class of buildings or structures is determined according to the state of the constructions depending on the available deformations in these buildings or structures.

The class of foundation bed of the buildings, permissible velocity of soil vibrations [v] near by the buildings and structures. Then it is necessary to establish the permissible distance from the piles to be driven to the buildings and structures in accordance with the requirements.

Observation of Buildings State, including leveling, is also carried out before execution of piling and in the course of it as well as during subsequent period until stabilization of deformations of structures and settlements of foundations.

Different devices (screeds, crack meters etc.) are used for observations of deformations of buildings while driving piles. These devices are placed inside the building within 30 m. distance of the nearest piles.

It is not necessary to assess a vibrations hazard for building structures if the distance from these buildings and structures to the nearest piles being driven is no less than 20 m. and the natural bases consist of layers of homogenous medium density sandy soils as well as clayey soils with a consistency J_a <1.

The permissible distance from piles to be driven [τ] to buildings and structures was calculated from ,the figure of permissible velocity of soil vibration [ϑ], damping factor of soil vibration with a distance δ (1/m) and velocity of soil vibration ϑ_0 (cm/c).

Velocity of soil vibration at a distance of τ (m) from the pile to be driven is calculated from the formula

$$\vartheta = {}^{\vartheta}\,O \sqrt{\frac{3}{t} e^{-d(t-3)}} \qquad (1)$$

where ϑ_0 – velocity at a distance of 3m from the pile, cm/c. In case when it was necessary to drive piles at distances which are less than those stipulated in the above item then the damages of buildings and structures are predicted according to Regulations in which the conditions of piles driving are close to the design ones. It was necessary to compare the design value of conditional summary dynamic effects W with the value W_n cited in the example.

The summary dynamic effects are calculated from the formula.

$$W = \sum N_{cp}\, \xi n_i\, \vartheta_I \qquad (2)$$

where N_{cp} - the average number of blows while driving of one pile. This number is determined from the examples of one Appendix 1and than according to results of trial piles driving.

n_I - the quantity of piles to be driven in i-u zone between concentric circles of radii 3; 5; 7; 9; 12; 15 and 20m. the concentric circles are drawn from the considered point of building;

ϑ_u - the velocity of soil vibrations at a distance of 3; 5; 7; 9; 12; 15 and 20 m from the pile. This velocity is calculated from the formula (49 taking account of measurement while trial piles driving.

ξ - the coefficient taking account of decrease of summary dynamic effects while driving piles into leading boreholes.

If the squares of leader and pile correspond F_{leader} / F_{pile} = 0.7 0.5then the rough values of the coefficient ξ are equal accordingly for sands from 0.5 to 0.6, for clays-from 0.4 to 0.5. While driving piles without leading boreholes ξ =1.

The value of the coefficient ξ was determined according to the results of trial piles driving:

$$\xi = \sum_1 AN / \sum_1 A_\Lambda N_\Lambda \quad (3)$$

where A_Λ and A- peak values of soil displacement while driving piles to the leading borehole and to the ground respectively without drilling of hole. These values should be measured after each meter of a driven pile, -the length of pile.

N_Λ and N- number of blows while pile driving to the leading hole and to the ground respectively without drilling of hole.

If the values W and W_n are approximately equal then there is a possibility that the building or structure will receive injuries that are similar to the injuries cited in the corresponding example. In cases when the estimating injuries will be admitted as impermissible ones or W>>W_n, then it is necessary to increase distance from buildings to the nearest to the piles or to change the piles location. It was necessary to record of three displacement components – vertical z and horizontal radial x and y in each point.

According to the records of displacement the greatest vibration swings was selected, frequencies and amplitude of displacement was determined. The vibration velocity that complies with a maximum displacement is calculated from the formula:

$$\vartheta = 2\pi Af, \quad (4)$$

where A-displacement amplitude (a half of the greatest swing) ; f=1/2t vibration frequency (t-time between amplitudes according to which the greatest swing is determined).

A damping factor of soil vibrations with a distance

$$d = \frac{1}{17} \ln \frac{J_0}{J} \text{ - 0.0.56,} \quad (5)$$

where ϑ_- and ϑ - vibration velocities at distances of 3 and 20 m. respectively. These velocities are calculated from the formula (4).

It was necessary to determine simultaneously peak values of displacements under vibrations of building or foundation for equipment and soil in order to calculate the gain factor of soil vibrations to the building or the foundation for equipment.

A vibration gain factor.

$$k = A_f / A_s \quad (6)$$

where A_s and A_f – peak values of displacements of soil of isolated foundation for equipment or a building respectively.

Estimated values for the field site are as such , damping factor S=0.0523 1/m, vibration velocity of soil 9 cm/sn at 3 meters, 1.4cm/sn at 20m, 1.4 cm/sn at 20 meters distance. Dynamic effect is estimated to be W=64733 and was measured to be W_n =63294 (W>W_n). Because of this imper missible inequality injuries of damages are expected at the building structures.

Vibrations gain of soil at the building foundation is k=2.5 and velocities 0.37 cm/sn at foundation level, ground level 0.89 cm/sn, at first floor 0.24, at second floor 0.18, at third floor 0.144 cm/sn, at fourth floor 0.21 cm/sn. Induced vibration level at a building, which are 45 meters apart from the machines, is equal the earthquake intensity of 3, in Mercalli Cancani scale.