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HOW TO SELECT THE RIGHT VIBRATORY HAMMER

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INTRODUCTION

The penetration speed by pile installations with vibratory hammers is influenced by:

- Soil condition.
- The force of the vibratory hammer (centrifugal force).
- The eccentric weight of the vibratory hammer.
- The weight of hammer.
- The weight of the pile.
- The shape and type of pile.

For selecting the right vibratory hammer for a pile installation some general rules apply.

Soil Conditions

Sand, gravel, and soft soil are especially suited for vibrating. Well graded sand is easier to vibrate than uniform sand. Round grains are easier to vibrate than sharp sand. Dense sand gives higher penetration resistance than loose sand requiring larger vibratory hammers with higher centrifugal force to overcome the resistance.

Clay with firm consistence is less suited for vibrating. The size of the amplitude is the major criteria for the ability of the hammer to vibrate the pile.

It is impossible to vibrate soils with bigger stones and rock.

The higher the water content in the soil the easier it is to vibrate the pile. Dry soil has higher penetration resistance than saturated soil and requires larger vibratory hammer.

Thumb rules

For clay:

The amplitude is important and must be higher than for sand. The necessary M_{ecc} in kgm must be 4 to 5 times the pile weight in tons.

For sand:

The amplitude is less important than for clay, but should be between 3 and 6 mm.

Pile weight less than 10 tons

The centrifugal force F_C in tons should be 10 to 15 times the pile weight in tons.

Pile weight between 10 and 20 tons

The centrifugal force F_C in tons should be 8 to 10 times the pile weight in tons.

Pile weight over 20 tons

The centrifugal force F_C in tons should be 5 to 8 times the pile weight in tons.

Centrifugal force, rotational speed and eccentric moment is specified for vibratory hammers in the data sheets from the hammer manufacturers. If not available, the centrifugal force can be calculated from the formula below.

Amplitude must always be calculated for a given job as the value stated in data sheets from the manufacturer does not include the weight of the pile.

FORMULAS AND VALUES

For detailed explanations of formulas, please refer to the Nor-Trade report, "Vibratory hammers for pile driving".

The formula for centrifugal force:

Centrifugal force of vibrator $F_c = M_{ecc} (2\Pi n/60)^2$ [N]

Here M_{ecc} is the eccentric moment and n the rotational speed per minute of the vibrator.

Formula for amplitude:

Amplitude during vibration $A = 2000\ M_{ecc}/m_{dyn}$ [mm]

Here m_{dyn} is the dynamic weight, which is the total weight of oscillating parts, e.g., the weight of the vibratory case, the clamp AND the pile. In data sheets from the manufacturer the dynamic weight comprising the vibratory case and clamp is specified.

Example - Calculation of amplitude and centrifugal force

Amplitude

Installation of a 14 m double AZ 26 sheet piles with a vibratory hammer with the following specifications:

M_{ECC} = 46 kgm

M_{dyn}= 5050 kg (hammer and clamps).

n = 1600 rpm = 26,7 rev/sec.

The weight of a double AZ26 per m is 252,4 kg so total weight of the pile is 3534 kg. Hence the total dynamic weight of hammer and pile is M_{dyn}= 8584 kg.

Therefore $A = 2000 \times 46/8584 = 10{,}7$ mm

Centrifugal force

For the same vibratory hammer and double sheet pile the centrifugal force will be:

$$F_c = 46 \times (2\Pi \times 26{,}7)^2 = 1295 \text{ kN}$$

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