Session 6

High strain dynamic testing of driven and cast insitu piles Dynamic testing of large piles

Bob Stevens, keynote lecturer session 6

Modern strain transducers and accelerometers are robust enough to monitor the driving of the largest piles driven with the largest hammers. Computers are powerful enough to perform calculations in real time, recording thousands of hammer blows continuously for analysis. The question is now how to best use the results

Pile monitoring is routinely used to obtain driving system performance data such as hammer efficiency, system efficiency, cushion stiffness, and cushion coefficient of restitution.

It is possible to evaluate pile acceptance in the case of premature refusal or easy driving, and to recommend remedial measures, such as placing a grout plug, drilling a pilot hole and redriving, or installing a driven or drilled-and-grouted insert pile.

It is also possible to follow a programme of controlled hard driving if the force and velocity time records indicate that driving stresses are acceptable and the end bearing is decreasing or erratic.

Pile acceptance at refusal is simplified when pile driving hammers used are large enough to overcome the long-term static pile capacity.

Soil resistance to driving determined from wave propagation theory (eg Case-Goble bearing capacity) and a signal matching analysis (eg CAPWAP) can be considered a lower bound because more resistance is mobilised at larger pile displacements.

Piles with adequate lateral capacity refusing above design penetration can be accepted if:

- the required tensile and compressive pile capacities are obtained from the upper bound static pile capacity curves
- the required tensile and compressive capacities are confirmed by the soil resistance to driving obtained from a CAPWAP analysis
- the required compressive capacity is confirmed by the soil resistance to driving obtained from the Case-Goble formula and wave equation analyses performed using the measured driving system performance data (ie hammer efficiency, cushion stiffness and cushion coefficient of restitution) and the field blow count.

Typically, the pile driving hammer may be large enough to drive the piles to design penetration but not large enough to overcome the long-term static capacity. In clay, the skin friction during driving is generally much smaller than that mobilised under static loading because large excess pore pressures are generated during continuous driving.

CAPWAP analyses can be used to estimate the distribution of the soil resistance to driving along the length and at the toe of a pile during continuous driving and after a set-up period. By combining these results, it is possible to "proof-test a pile" without the expense of mobilising a larger hammer to the site.

High strain dynamic testing can also be used to evaluate the capacity of cast insitu piles (also known as drilled shafts or bored piles).

Hussein, Likins, and Rausch (1996) made recommendations concerning the hammer weight, drop height, and cushion thickness.

The hammer weight should be at least equal to 1.5% of expected capacity, hammer drop height should be about 8.5% of pile length – with a minimum value of 2m. The thickness of the plywood cushion is determined from:

$t = L^2/2D$

where: t=cushion thickness (mm)
L = pile length (m)
D = pile diameter (m)

Minimum cushion thickness is 100mm and this should be increased to 150mm when pile length exceeds 30m.

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