Bending of a pile segment for testing the efficiency of a center pipe probe
Courtesy of F. C. Clemente, 1976

FELLENIUS, B.H., 1980

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# THE USE OF CENTER PIPES IN PRECAST CONCRETE PILES

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A center pipe for placement in a precast concrete pile usually consists of small diameter, 1.5-inch (40 mm) steel tubing cast concentrically in the pile. Sometimes, for purpose of special testing, such as telltale instrumentation in combination with inclinometer measurements, larger diameter center pipes are used. Up to 6 inches (150 mm) pipes have been used in practice in 16-inch (400 mm) piles. For cost reasons, the larger center pipes often consist of pvc-pipes. (When center pipes larger than 6 inches are used, the pile is more to be considered a hollow pile, or a hollow-core cylinder pile, with a certain wall thickness).

It is important that the splicing of the center pipes in the casting form is made without lips or burrs on the inside obstructing the pipe. When using pvc-pipes, it must be considered that the pvc exhibits an appreciable thermal expansion and contraction, as a result of the heat generated during the curing of the concrete. Conical connections are therefore unsuitable.

In mechanically spliced piles, the center pipe is taken through the splices by means of a special standard arrangement, which supports the center pipe through the splicing plates and ensures that it is truly perpendicular to the plates. The splicing plates must be equipped with o-ring seals. Otherwise, due to the very large pore pressures generated and the remolding of the soil nearest the pile surface during the pile driving, soil would enter the center pipe and costly cleaning work would be required after the driving. That the seal is properly designed and arranged is essential. For instance, the author has observed that the center pipe in 200 ft (60 m) long spliced pile filled completely with clay due to a faulty o-ring in one of the splices.

The primary purpose of the center pipe is to provide access down to the pile for inspection of the integrity of the pile. Just by looking down the pile, much assurance is gained. In addition, a simple check can be made on potential doglegging of excessive bending by lowering a special plumb-bob (probe) into the center pipe. The probe is then designed to jam in the pipe, if the curvature of the pile would be excessive — if the pile is bent to a smaller bending radius than a certain value. The geometrical design of the probe is given by Fellenius (1972) according to the following simple relation:

$$R = \frac{L^2}{8h}$$

where
- R = the bending radius of the pile.
- L = probe length.
- h = difference between the inside diameter of the center pipe and the outside diameter of the probe

Usually, the probe is designed for a limit bending radius of 300 ft (100 m) to 600 ft (200 m). This range is far from conservative, but takes into consideration various practical factors, such as the tolerances of pipe dimensions and ovalities of the pipes, which make the probe stop at a smaller curvature that the mathematics indicate. The limit bending radius of 300 ft (100 m) should be considered in the light of that concrete piles experience severe cracking, when bent to this value, and in the case of steel piles, the yield strength of the steel material is reached. (The inspection of a pipe pile by means of a probe down the pile applies equally well to the inspection of these piles).

Adding center pipes to precast concrete piles increases in-place cost per unit length of the pile about 10 percent. However, properly handled, the total costs are reduced. The tremendous assurance gained by adding center pipes to the pile and carrying out a qualified inspection through these, will in almost every case justify an increase of the design load. Personally, the author has experienced projects, where, if the center pipes in the piles had not been used, a reduction of the recommended safe allowable load would have been necessary, whereas having the center pipes resulted in a recommendation to use increased allowable loads. A load increase of at least 20 percent is almost always applicable.

Naturally, all piles must be equipped with center pipes, not just a few test piles, indicator piles, or replacement piles, of 10 percent of the piles, etc.

Center pipes have additional advantageous uses. For instance, providing a center pipe in a pile selected for a static loading test lends itself very obviously, and very cheaply, to accommodate a rod to the bottom of the pipe. This rod is then used to record the pile toe movements during the load testing. Leonards and Lovell (1979) have shown what tremendous value that very quickly can be gained from this simple "instrumentation".

Center pipes provide the possibility of jetting a pile through dense soil layers in order to reduce driving time, increase penetration, and/or reduce bending.

Standard arrangements are available for pile shoes and driving plates, which will allow the jetting through the soil, when required. The practical advantage is that standard pile segments are used. Therefore, if jetting is found to advisable at a site, this can be resorted to without much cost increase or delay, provided the piles are already equipped with center pipes.

Again, with a slight change of pile shoe, the center pipe can be used to insert a drill rod through the pile and to drill beyond the pile toe for grouting a soil or rock anchor into the ground, when in need of an increased tensile capacity. Or in the case of a pile driven to sloping bedrock, when the pile-toe support even when using rock shoes is doubtful, a steel rod can be dropped through the center pipe and beyond the pile toe into a drilled hole and grouted to provide the desired fixity of the pile end.

As an add-on comment, the author has used the same principle and method to test closed-toe steel pipe piles for bending. The pipe pile is in effect the center pipe, and a smaller pipe is used at a length and diameter according to the formula above to react for the limiting bending radius.

**References**

FELLENIUS, B.H., 1972: Bending of piles determined by inclinometer measurements, Canadian Geotechnical Journal, Vol. 9, No. 1, pp. 25 - 32.

LEONARDS, G.A. and LOVELL, D., 1979: Interpretation of load tests on high capacity driven piles, American Society for Testing and Materials, ASTM, Symposium on Behavior of Deep Foundations, Boston 1978, ASTM STP 670, R. Lundgren Editor, pp. 388 - 415.