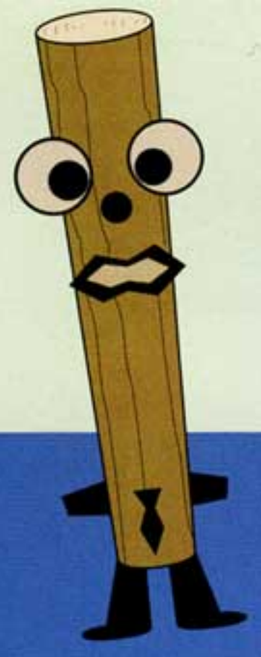

Did You Know?

While relaxation for humans is generally viewed as beneficial, relaxation for driven piles can be quite problematic. While the vast majority of piles experience a capacity gain called "set-up" after installation, pile relaxation is a reduction in ultimate capacity after the initial installation. In some cases relaxation of 50 percent off end of drive capacity has been observed. Many contractors recognize relaxation from local experience - a pile may fail a static load test, or a pile may refuse early but then the blow count may decrease after a wait period and allow additional penetration of the pile. Also, engineers may observe the capacity reduction from dynamic pile testing, comparing results from end of drive to those from early blows of a subsequent restrike.

Relaxation occurs primarily at (or at least near) the pile tip. It occurs in three primary situations:

1. **Weathered Shale:** Relaxation is typically observed when H piles, open-end pipe piles, and even closed- end pipes are driven into weathered shales. Excess normal pressures created by the pile displacement can plastically flow away, or water can seep along the pile or other chemical effects may diminish the shale strength. An example of shale relaxation has been described by Morgano et al., 2004 .
2. **Dense Silt:** Relaxation has also been observed when driving displacement piles into dense saturated silts, or sands with high fine content where drainage is poor. In this case, negative pore pressures develop at the tip during driving, causing a temporary effective stress increase, and hence end-bearing increase at the pile toe. Relatively brief wait periods allow the pore pressures to increase back to normal, reducing effective stresses with a resulting loss of end-bearing resistance. Since the shaft may simultaneously experience set-up in such soils, sometimes these effects offset each other and the result is similar capacity at end of drive and restrike and perhaps a lower than expected ultimate capacity.
3. **Heave:** "Heave" of a perfectly installed pile may be caused by the subsequent driving of nearby displacement piles and the associated upwards soil flow. Thus heave primarily reduces the end-bearing of the previously driven pile. A similar effect on previously driven piles may be caused by fracturing of bedrock from subsequently driven piles.

In the case of shale or dense silts, redriving the pile will again increase the pile capacity to the driving condition, but only temporarily, and in time will again revert to the relaxed condition. Generally, the pile must either be driven initially to a higher ultimate capacity than required (overdriving) for sufficient long term capacity after relaxation, or, if that is not possible, the assigned ultimate capacity of the pile reduced. Alternatively, increasing the number of test piles may allow for a reduction of the factor of safety and thereby reduce the number of additional piles. For heave, reseating the pile usually restores the pile to full capacity.

When relaxation occurs, it is generally complete in a relatively short time; perhaps as short as a day or two but never in our experience more than a week. The ultimate capacity of the pile in its long term service condition can be determined after the appropriate wait following initial installation by either a static load test, or a restrike dynamic test. The dynamic tester must then be careful to analyze the record of an early restrike blow with the pile still in the relaxed condition to assess the extent of the relaxation.

Contributor: Garland Likins, Pile Dynamics, Inc. (August 2009)

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[1]*Morgano, C.M., White, B., August, 2004. Identifying Soil Relaxation from Dynamic Testing. Proceedings of the Seventh International Conference on the Application of Stresswave Theory to Piles 2004: Petaling Jaya, Selangor, Malaysia; pg 415-421.*