Dynamic Analysis of Plugged Pipe Piles in Clay

Principal Investigator: Samuel G. Paikowsky
Graduate Research Assistant: Les R. Chernauskas (MSc)
Research Funded By: Air Force Office of Scientific Research & NSF
Date: Spring 1994

ABSTRACT

An open ended pipe pile can become plugged when sufficient frictional resistance is developed by the inner soil cylinder within the pile (soil plug), thereby preventing further intrusion of the soil into the pile. When plugging occurs in an impact driven pipe pile, a complex interaction between the pile and soil plug takes place, causing the propagating stress wave to undergo an abrupt change. Current dynamic analyses of piles are based on the one-dimensional wave equation (e.g. CAPWAP, TEPWAP). Although the wave equation has the capability to indirectly accommodate the inner soil cylinder, it does not accurately simulate the physical phenomena when the pile is plugged, causing the predicted capacity of plugged piles to differ from actual field observations.

A new approach was investigated in which the spatial stress transformation within the soil plug was modeled using an axi-symmetric wave propagation formulation. A two-dimensional finite difference solution was developed for that formulation. This numerical solution was implemented in a computer program called PWAP (Plug Wave Analysis Program). A case study was then used to examine the applicability of the solution and to determine if the static capacity of the pile could be predicted more accurately. The PWAP analysis was performed on a pipe pile driven in Empire clay using dynamic records taken from a well documented case study. The results of PWAP were compared to the results of TEPWAP and CAPWAP, which do not simulate the effects of soil plugging. The PWAP analysis resulted in a better force match than the conventional analyses and predicted the pile capacity to 87% of the load test value, compared to about 30% for the conventional method predictions.