Wave Equation Analysis

In the 1950's, E.A. Smith of the Raymond Pile Driving Company studied wave propagation on slender rods, and developed a numerical analysis method to predict the capacity versus blow count relationship and investigate pile driving stresses. The model mathematically represents the hammer and all its accessories (ram, cap, cap block), as well as the pile, as a series of lumped masses and springs in a one-dimensional analysis. The soil response for each pile segment is modeled as viscoelastic-plastic. All components of the system are realistically modeled.

The analysis begins with the hammer ram falling and attaining an initial velocity at impact. This method is the best technique for predicting the relationship of pile capacity and blow counts (or set per blow), and the only method available to predict driving stresses. Download the freeware PDI-Wave to visualize wave propagation after ram impact, as well as resulting forces, velocities, stresses and displacements.

Improvements to Smith's method include work by GRL to incorporate a thermodynamic diesel hammer model and residual stresses. The GRLWEAP Wave Equation Analysis of Piles program is based on Smith's method. The wave equation approach is an excellent predictive tool for analysis of impact pile driving, but it has some limitations. These are mainly due to uncertainties in quantifying some of the required inputs, such as actual hammer performance and soil parameters.