Numerical Modeling of Concrete Flow in Drilled Shaft Construction

J. Asirvatham [1], G. Mullins[1], A. E. Tejada-Martinez[1]

[1]Department of Civil and Environmental Engineering, University of South Florida, Tampa, FL, USA

Abstract

Drilled shafts are cylindrical, cast-in-place concrete deep foundation elements used for heavy structures such as highway bridges and tall buildings. Construction involves drilled excavation of soil or rock using large diameter augers to form a deep cylindrical void, placement of the necessary reinforcing steel in the excavation followed by concreting. Where high water table is encountered, drilling slurry is generally used to support the excavation walls and concreting is always tremie-placed. Even though the history of drilled shaft construction goes back to 1950s, the occurrence of anomalies still persists in the form of soil inclusions, reduction in shaft cross sectional area, and exposure of reinforcement. One of the main reasons for the anomalies is attributed to the kinematics of flowing concrete inside the excavation containing the reinforcing steel.

A research program is presently underway with 3-D modeling of drilled shaft concreting using COMSOL Multiphysics® software. This can take into account the fluid flow with rheological properties and effects of structural blockages. Hence, the influence of the size of drilled shaft, size of reinforcement and arrangement of the bars can be analyzed. For the motion of fluid flow, non-Newtonian behavior is considered and level set method is used for computing the motion of the interface between concrete and the drilling slurry. To start with, 2-D models were carried out for 4-minute simulation times and the flow patterns and volume fraction of concrete and slurry were determined. Results are encouraging as the flow patterns obtained are consistent with those observed at project sites.

1 PhD Student, Dept. of Civil and Environmental Engineering, USF, Tampa, FL, 33620.
2 Associate Professor, Dept. of Civil and Environmental Engineering, USF, Tampa, FL, 33620.
3 Professor, Dept. of Civil and Environmental Engineering, USF, Tampa, FL, 33620

Figures used in the abstract

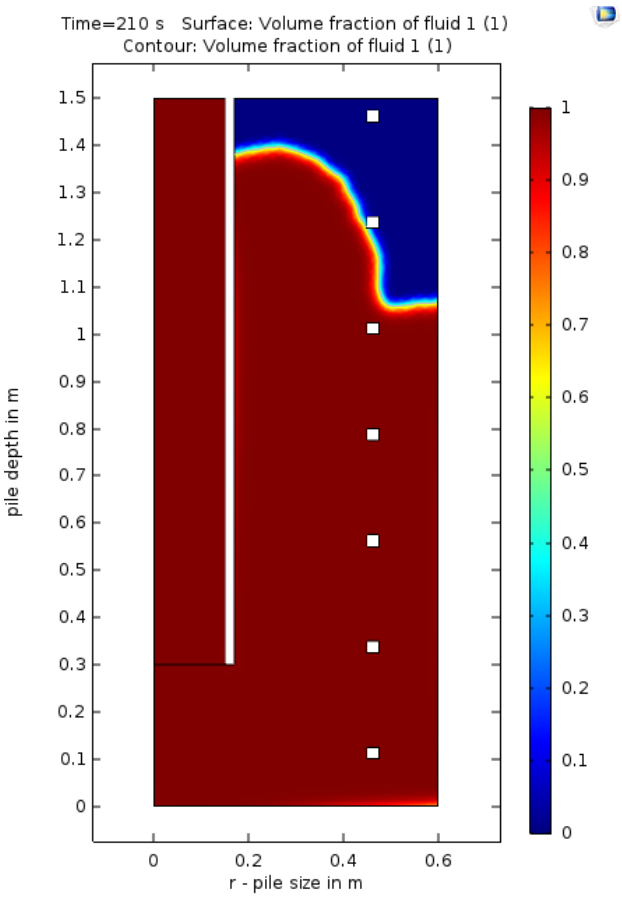

Figure 1: Concrete flow in Drilled shaft - 2 D Axis Symmetric