Modelling the Capacity of Suction Caisson Anchors based on Fuzzy Theory

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ABSTRACT
This paper develops a fuzzy model for predicting uplift capacity of suction caisson foundations for offshore platforms. The aspect ratio of the caisson ($L/d$), the undrained shear strength of the clay soil in which the caisson is installed ($S_u$), the relative depth of the lug to which the caisson force is applied ($D/L$), the angle that the chain force makes with the horizontal ($\theta$), and the loading rate defined with respect to the soil permeability ($T_k$) are used as the input variables. The output of the proposed fuzzy model is the predicted ultimate capacity of the suction caisson. The benchmark artificial neural network (ANN) model is used as baseline. Comparisons of the trained fuzzy model with the data demonstrate and the results of ANN that the proposed modeling framework is an effective way to capture complex behavior of suction caisson systems.

KEY WORDS: Fuzzy model; artificial neural network (ANN); uplift capacity; suction caissons; system identification

INTRODUCTION
The foundations and anchors for offshore structures have been actively studied by the oil and gas industry. Under new demands for offshore wind energy, the knowledge gained in designing offshore oil platforms can be applied to the development of foundations for offshore wind turbines. Authors are currently involved in a research project (KETEP 2014) whose scope is to develop fundamental models to analyze and design the substructure/platform for the floating wind turbine. This project is comprised of several modules which include the investigation of the suction caisson anchor as an anchoring option for floating systems. Fig. 1 shows an example of the concept of floating wind turbine anchored with suction caisson anchors.

Suction caissons are one of the most effective and most widely used anchoring systems for deep water offshore structures (Andersen et al. 2005; Andersen et al. 2003; Samui et al. 2011). Past research on the suction caissons has included analytical studies (Wang et al. 1978; Murff and Hamilton 1993; Aubeny et al. 2001; Aubeny et al. 2003; Randolph and House 2002; Watson et al. 2000; Randolph and Houlshby 1984; Martin 2001), numerical analysis (El-Gharbawy and Olson 2000; Zdravkovic et al. 1998; Cao et al. 2001; Cao et al. 2002; Cao et al. 2003), laboratory testing (Goodman et al. 1961; Finn and Byrne 1972; Watson and Randolph 1997; Larsen 1989; Steensen-Bach 1992; Cauble 1996; Datta and Kumar 1996; Singh et al. 1996; Rao et al. 1997; Rao et al. 1997; Luke 2002; Coffman et al. 2004), and prototype model tests (Hogervorst 1980; Tjelta et al. 1990; Dyvik et al. 1993; Andersen et al. 1993; Cho et al. 2002).

![Fig. 1. Conceptual configuration of suction caisson anchor](image-url)