USING ANNS AND REGRESSION TREES APPROACHES TO ESTIMATE SCOUR DEPTH AROUND A CIRCULLAR PILE DUE TO WAVE IN MEDIUM DENSE SILT AND SAND BED

Mohammad Karim Ayoubloo
Iran University of Science and Technology
Mo_ayoubloo@civileng.iust.ac.ir
Tel: +989192162883

Amir Etemad-Shahidi
Iran University of Science and Technology
Etemad@iust.ac.ir
Tel: +982173913170

Javad Mahjoobi
Ministry of Energy, Water Research Institute
Jmahjoobi@gmail.com
Tel: +989151254211

ABSTRACT: Prediction of scour around a pile due to oscillatory wave action is very important in many offshore and marine engineering problems. Because of complexity of scour process, most of the empirical formulas are unable to estimate scour hole depth accurately. Artificial Neural Networks (ANNs) and regression trees are efficient procedures to understand and model complex systems with ambiguous relations. A Multi Layer Perceptron (MLP) is one of the most common kinds of ANNs and has been used to map input-output systems while CART algorithm was employed for building and evaluating regression trees. In the present study, two input sets were employed to estimate scour depth: (a) dimensional parameters such as bed grain size, pile diameter, wave period, wave height, maximum flow velocity and maximum shear velocity (b) nondimensional parameters such as pile Reynolds number, Shields parameter, Keulegan-Carpenter number, grain Reynolds number, sediment number and relative density. Output parameter was nondimensional equilibrium scour depth. The tests results reveal that a MLP with back propagation learning rule and CART model based on nondimensional parameters can predict scour hole depth better than the existing empirical formula. Also, a sensitivity analysis was carried out and it showed that Keulegan-Carpenter number and wave height are the most important parameters in scour process.

Keywords: Artificial Neural Network; Pile; Regression tree; Scour; Wave

INTRODUCTION

Piles are extensively used as a principle element in marine and coastal structures. When a pile is installed on the sea floor, because of interaction between wave and current and a pile, scour occurs in the vicinity of the pile. Commonly scour leads to changes in the capacity of the sediment migration on an erodible bed. Scour process can finally cause to complete failure and collapse of a marine structure. Therefore, accurate estimation of scour depth around a pile is very important and has to be considered.

Many studies about scour around a pile in wave have been performed during the past decades. Sumer et al. (1992) and Kobayashi and Oda (1994) displayed Keulegan-Carpenter number as the main parameter governing the scour process. Also Sumer et al. (1992) presented an experimental expression to predict scour depth. The influence of pile geometry, using square and circular pile, has been investigated by Sumer et al. (1993). Further Sumer and Fredsoe (1998) carried out a laboratory study around different arrangements of pile groups. An investigation of the scour around group of piles in the field due to oscillatory wave has been performed by Bayram and Larson (2000). They found a distinct correlation between scour depth and Keulegan-Carpenter number. Recently Sumer et al. (2007) implemented an experimental investigation on wave scour around a circular pile in three kind of soil so called dense silt (with relative density of $Dr = 0.74$), medium dense silt (with $Dr = 0.38$) and sand (with $Dr = 0.23$). They showed when the bed was dense silt the scour depth was increased by a factor of 1.6-2 relative to two others.

It is very difficult to find a mathematical model that exactly shows the scour process developing under effect of wave and current. There several governing parameters interacting with each other complicatedly in the scour process. In spite of existing investigations, there is no reliable and