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DETERMINATION OF THE MOST EFFECTIVE PARAMETERS ON SCOUR DEPTH AT COASTAL STRUCTURES USING GENETIC PROGRAMMING (GP)

Ali Pourzangbar[1]

Key Words: Scour, Coastal structures, Genetic programming (GP), Effective parameters

Introduction

When a structure is placed in a marine environment, the presence of the structure will change the flow pattern in its immediate neighborhood. These changes usually cause an increase in the local sediment transport capacity and thus lead to scour [1]. Scour is one of the failure modes of breakwaters. Breakwater failures due to scour have been reported in a recent report from the US Army Corps of Engineers (Lillycrop and Hughes, 1993) and in a recent review paper by Oumeraci _1994 [2].It is very costly to repair these structures; therefore, proper initial design and construction methods are imperative. To properly design seawalls, it is important to be able to estimate the potential amount of scour or loss of sediment at the toe [3]. This study presents an alternative to the conventionally regression-based equations in the form of genetic programming (GP) to determine the most effective parameters on scour using the compiled data sets from published literatures. Statistical parameters including root mean square error and correlation coefficient are used to measure the evolved model's performance.

Previous investigations

Xie [4] experimentally studied the scour pattern at vertical breakwater under action of standing waves. He indicated that there are two different patterns of scour-deposition in front of the toe of vertical breakwater depend on sand properties and incident wave characteristics. Moreover, he used the relative water depth in his formulation. Fowler [3] experimentally investigated the scour in front of vertical seawall. He deducted that in addition to pre-scour depth of water at the base of the wall, deep-water wave height and length are the major governing parameters on the scour.

Sumer and Fredsoe [2] considered the steady steaming resulted from standing waves as a key mechanism in the Scour process. Furthermore, they studied the effect of breakwater slope on the maximum scour depth. Lee and Mizutani [5] mentioned that depending on reflection coefficient, the value of maximum scour can be smaller in the case of submerged breakwater.

[1] M.Sc. student, Iran University of Science and Technology, ali_pourzangbar@civileng.iust.ac.ir

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Genetic Programming

GP is first proposed by Koza [6].It is a generalization of genetic algorithms (GAs) (Goldberg, 1989).The GP is similar to Genetic Algorithm (GA) but employs a ''parse tree'' structure for the search of its solutions, whereas the GA employs bite strips. As the population evolves from one generation to another, new models replace the old ones by having demon- strably better performance. The evolution starts from an initially selected random population of models, where the fitness value of each model is evaluated using the values of the independent and dependent variables [7]. Fig.1 shows the GP flowchart. In this study, relative water depth, serf similarity parameter, incident wave steepness, Shields parameter, Reflection coefficient and $\frac{U_m - U_{cr}}{W}$ (the criterion initiation of bed sediment suspension under waves proposed by Xie) are introduced as the effective parameters. To determine the most effective parameters using GP, various models have evolved with different combinations of input parameters.

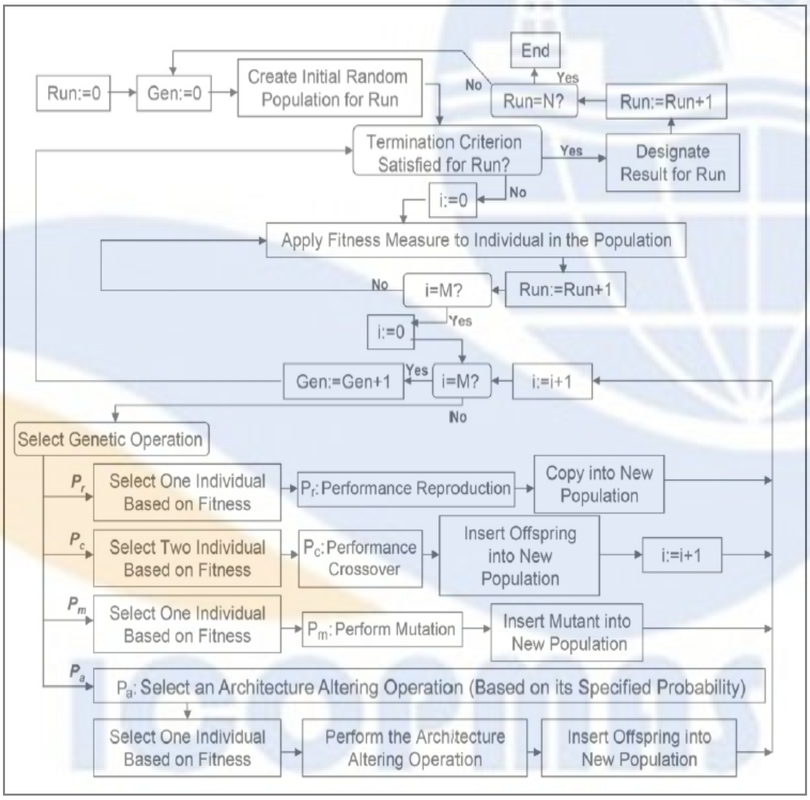

Fig. 1) Genetic programming flowchart [7]

Conclusion

The results of sensitivity analysis by GP models showed that the relative water depth at the toe ($\frac{h_{toe}}{L_0}$) and Shields parameter are the most important variables.Fig.2 indicate the results of sensitivity analysis with Ir, h/L, and Cr as the input parameters with respect to two function sets.

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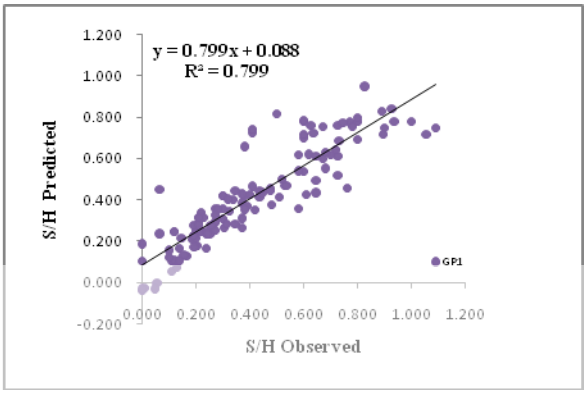

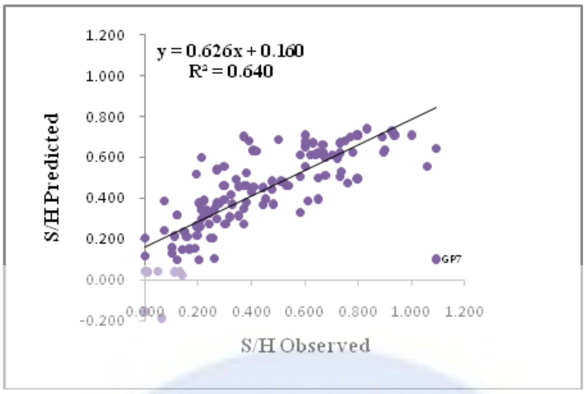

Fig .2) Results of sensitivity analysis by GP with Ir, h/L, and Cr as the input parameters

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