Soil Structure Interaction using Soft Computing Techniques: A Review

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Abstract: **Soil Structure Interaction (SSI) using Soft computing techniques is rarely studied. Recently the structural analysis problems are analyzing with the help of soft computing techniques, as these techniques deal with real-time models and give better solutions to the complex problems. This study is an overview of soft computing techniques like Artificial Neural Network, Fuzzy Logic and Genetic Algorithm applied for Soil Structure Interaction analysis and their comparison with analytical and empirical methods. These concepts are overviewed by summarizing the several studies.**

Keywords: **SSI;Soft Computing Techniques; ANN; Fuzzy Logic; Genetic Algorithm**

1. INTRODUCTION

The seismic response of any structure strongly depends on the type of foundations and soil media, where the soil mass stimulated by any earthquake ground motion may affect the dynamic behaviour of the structure, this process is generally referred to Soil Structure Interaction (SSI). Taking reference on Cutch earthquake of 1819, India in which around 20,000 people were killed. MacMurdo (1824) made a statement that "Building were situated on rock soil were not by any means so much affected as those whose foundation did not reach the bottom of the Soil".

SSI is dominant for soft soil conditions rather in other conditions, as soil flexibility increases the base shear also increases in turn the natural frequency of the structure affects [4]. As dynamic shear modulus increases it causes the natural frequency of SSI, hence the shear modulus of soil is the main affecting factor to be constant and must be less than the critical level [13].

2. SOFT COMPUTING TECHNIQUES

Zadeh noted that soft computing tool is not one technique, rather it is a mixture of many ways, like neural networks, genetic algorithms and fuzzy logic, all these techniques are not competitory, but are favourable to each technique and may be applied along to resolve a complex problem [2]. It is stated that these techniques mainly aims to resolve advanced issues by removing the uncertainty and inaccuracy in decision making processes.

3. SOFT COMPUTING TECHNIQUES ON SSI

The experimentation results of Wilson 1998 and Stewart et al. 1999 are taken as references [5]. A Container having soil content has the dimension plan of 1.72*0.685 m and depth of 0.7m is utilized for the conduction of experiments. Five examples with different soil profiles prepared according to the reference results.

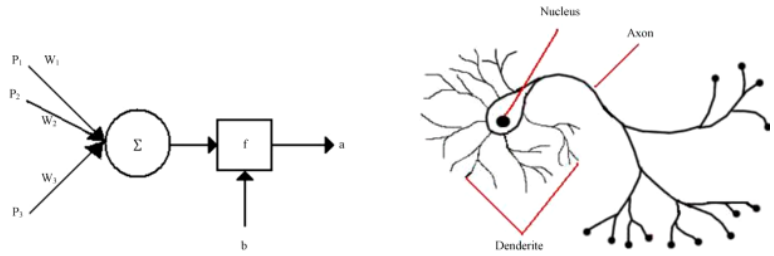

Fig. 3.1 Representation of single artificial neuron [5]

FEM method is applied to get the results for constructing ANN models. The number of piles, peak base acceleration, and mass on the column, length of columns and amplitude factor of the earthquake record are considered to be input parameters. The output parameters like the maximum acceleration of superstructure (Column head) and piles head [5]. Neuro solutions is used for analysis of ANN. ANN was found to be better than experimental and FEM models.

The effect of SSI using seismic record of 58 sites in California is investigated [11]. The expert system namely a neural network is used for SSI and land use. Analysis of five models are studied, two kinds of approaches are used i.e. back propagation for models 1 and 2 and general regression neural network approach for models 3, 4 and 5. Three stage processes like training testing and cross validation are done to avoid over fitting which uses back propagation [11]. This study has investigated. GRNN consists of 21 inputs and 4 outputs (period lengthening, foundation damping, the ratio of soil to structure stiffness and SSI negligible). It is found that GRNN is models are better performed and suitable than BPNN.

ANN for soil foundation interaction model with a learning sets based on 263 records of building foundations, tanks, embankments, the settlement on sand gravel [10]. The fuzzy, neural network method is used to quantify the uncertainty and system behaviour. Multilayer pattern of feed forward network is applied and back propagation neural network learning algorithm is used to reduce the errors. Uncertain parameters are analysed using fuzzy numbers, using this process for different uncertain inputs and different models, various levels of fuzziness can be used to deal with uncertainty. Structure response resting on cohesion less soil is studied by fuzzy–neural network method. ANN model shows better results than analytic and empirical solutions [10]. The fuzzy-neural network was effective in analysing soil uncertainty and predicting structure behaviour

Neural Network method has been adopted for solving SSI problems. Finite element analysis results are taken as training and testing sets [9]. Various parameters like different height/width ratios for different types of soil conditions, number stories and site depths of local sites are considered. The direct method is applied to solve SSI problems under the seismic loads. The results of a period, top storey displacement and top storey accelerations are analysed with the initial 10 seconds of 1940 EI Centro earthquake with time step limit of 0.02 seconds as input and 240 different soil structure models are analysed to extract training and testing sets. Back propagation method is used in the feed forward technique [9]. The results of NN and FEM are compared through graphs and the study has found that the proposed Neural Network results and FEA results are in near conjunct [9]. Hence the study concludes that the NN model can predict SSI accurately in comparison with FEA analysis

Six ANN models were modelled to extract the various responses of kinematic pile interaction mainly the kinematic behaviour for free head piles and fixed head piles with homogeneous soil layer [6]. The training and testing tests are extracted using the BDWF (Beam on Dynamic Winkler Formulation) approach. Fifty percent of the extracted results are used as training set and remaining as a test set. ANN model was developed by analysing the pile-soil system using BDWF method. To analyse the ANN models, the three types of soil pile models were subjected to four types of earthquake records, they are Tabas earthquake (Iran 1978), Fuiuli earthquake (Italy 1976), Northridge (1994), and Loma Prieta earthquake (1989). The study concludes that analysis of the kinematic interaction of piles using ANN models was almost close to the results of BDWF formulations. [6]

CONCLUSION

- Soft computing techniques are more accurate and powerful tool compared to empirical and analytical methods to solve SSI problems.
- As the soft computing techniques are rarely applied on SSI Problems, So these techniques have a wide range of future scope in the SSI investigation.
- Among soft computing techniques, ANN is widely used with back propagation algorithm as the results are close proximity with analytical and mathematical models.
- Other techniques like GA, Fuzzy logic and SVM also extract results near to the analytical and experimental results.

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