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Dynamic Analysis of Concrete Minaret Using Gene Expression Programming

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Abstract. This paper describes how we use Gene Expression Programming, an evolutionary computational optimization approach, in determination maximum displacement of top of minaret under earthquake force.
In this study, maximum displacement in top of minaret is calculated using SAP2000 software. 50 minarets with diameter of 2.5 meters and different thicknesses were analyzed. Then three calculated parameters in SAP2000 -length, diameter and thickness- and displacement in top of minaret (input and output, respectively), delivered to Gene Expression Programming for modeling , choosing the best model, delivering mathematical formulas and expression tree. Also, regard to maximum displacement in top of minaret using SAP2000 software, 50 extra samples created to test Gene Expression Programming. The models were tested and the results were presented in tables and diagrams.

Keywords: Gene Expression Programming, Genetic Algorithm, Minaret, Concrete.

1. Introduction

First introduced by Candida Ferreira (Ferreira, 2001), Gene Expression Programming (GEP) is a recently developed evolutionary computation method for data analysis and knowledge discovery. It is a new evolutionary algorithm that evolves computer programs. GEP is like genetic algorithm(GAS) and genetic programming (GP) a genetic algorithm as it uses population of individuals, selects them according to fitness, and produces genetic variation using one or more genetic operators(Mitchel, 1996). Born from genetic algorithms (GAS) and genetic programming (GP), GEP is both flexible at genetic operations due to its linear genotype and capable of retaining a certain extent of functional complexity due to its phenotype as expression tree.

Recently, different modeling methods based on soft computing system such as neural networks and fuzz logic have been widely used by many researchers for a variety of engineering applications (Subasi et al.; 1993, Yeh, 1998; Jung and Jamshid, 2001). The main approach for the modeling of material behavior using a soft computing system is to train a model with data of a series data of experiments. If the experimental results contain the related information about the material behavior, then the trained model will give adequate information about material behavior. Such a trained model not only would be able to produce the experimental results, but also it would be able to estimate the results in order experiment through its generalization capabilities (Zadeh, 1965). The Genetic Expression Programming (GEP) developed by Ferreira (2002), is a new method similar to such approach mentioned above. It is natural development of genetic algorithm. In GEP method, a mathematical function is encoded similarly to human chromosomes and the best function fitted to give data base is obtained by mutation process performed in GEP analysis (Binici et al., 2009).

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According some parameters such as diagonal, thickness and height of concrete minarets (slender tower built next to a mosque and is used by the muezzin), the gene expression programming function was presented.

Then after some genetic operators (reproduction, crossing, mutation and etc.) for each offspring, final population obtained which is maximum displacement in top of the minaret. Finally, the gene expression tree outputs were mathematical formula details for computing of maximum displacement in top of minarets. Also, to test of gene expression programming models, it is necessary to have secondary population by data. Then the results which are presented by SAP2000 software were compared by the best model of gene expression programming.

While most historical minarets were constructed using reinforced or unreinforced stone or brick masonry, the majority of minarets recently constructed are reinforced concrete structures (Sezen et al., 2008). Minarets include three distinct parts: base (boot), body (shaft) and cape. Because the minaret with high height and low area tolerates high pressures on its base area, weakness of bases leads to collapse of the structure. So, for more firmness and confidence, the ground will be dig deeply, and then it will be filling by foundation paste and stone. Then the platform or the main bases of minaret will lay the foundation by stone and brick. Usually, the bases are in shape of square or multisided and the minaret is located in the center of it (Javadi, 1984).

The minaret will be exposed to static and dynamic loads. The static loads include dead loads, live loads and pressure of changing temperatures loads. The dead and live loads are calculated by masonry density. Dynamic loads include inertia loads which are originated from structure vibration.

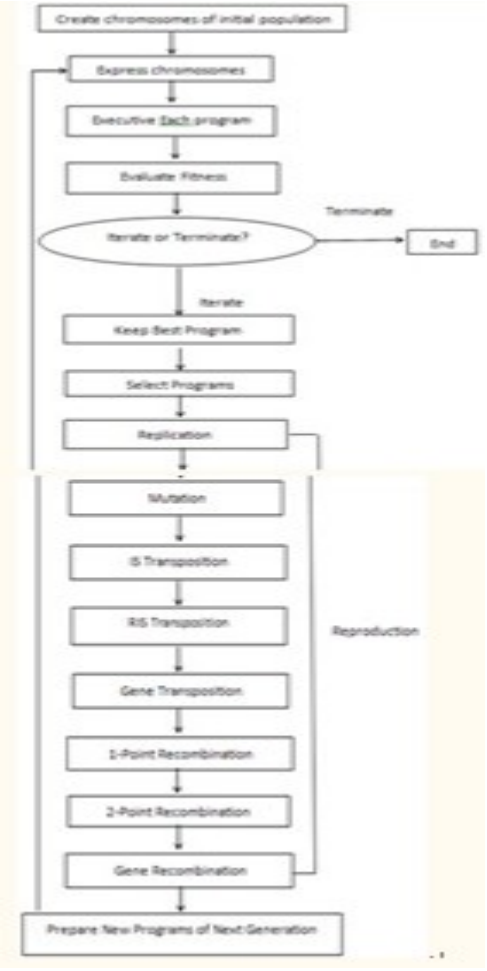

Figure 1. Gene Expression Programming
(Ferreira, 2001)

2. 2. Discussion

2.1. Dynamic analysis in SAP2000

In this paper, point of support in minaret base is fixed. Meshing minaret member is calculated in the best calcification (meshing is divided to smaller parts and is stopped so that the results don't change). To study of dynamic behavior of concrete minaret, three parameters- height, diameter and thickness- are used. The height, diameter and thickness are 21 to 66, 2.5 to 7 and 0.2 to 0.46m, respectively. Also, modeling is presented on a cylindered minaret with height of 30 m, diameter of 2 m and thickness of 20 cm.

2.2. Data Modeling Using Gen Expression (GEP)

In this study, minaret modeling using Gen Expression programming has been performed. General characteristics of used concrete minaret are provided in table 1. Then, the computer program, SAP2000, was used to analyze and calculation of top displacement of minaret.50 samples of concrete minaret chose and displacement in top of minaret as output analyzed .The results are presented in table 2.

Concrete specification	*Concrete compressive strength* $(f'c)$ *Kg/cm²*	*Density kg/m³*	*Young□s modulus (E) kg/cm²*	*Poisson's ratio* (υ)
Concrete minaret	*210*	*2400*	*2188197889*	*0.2*

Table1. General characteristics of used concrete minaret

3. 3. Results

3.1. Modeling using GEP for calculation of top displacement of minaret

Using the results in table 2 as primary population in gene expression programming, some models were provided. All models evolved by gene expression programming can be converted into programming language, including parse trees. These trees can be used to grasp immediately the mathematical models and therefore are ideal for extracting knowledge from data.

To test of gene expression programming models, the secondary population is needed. This population is unique and may not found in primary population. Then the results of minaret period, displacement of top of the minaret and base shearing of minaret, using SAP200 software are compared with the best model of gene expression modeling.

3.2. Comparing GEP and SAP2000 Software for Top Displacement of Minaret

Using SAP2000 software, the displacement of 50 samples of concrete minaret were calculated and compared with the best model of gene expression programming. The diagram of comparing displacement in top of minaret using SAP2000 software and gene expression programming model is presented in figure 5. Also, the diagram of comparing sample errors percent is presented in figure 6. In this model, the average of error percent is 13.21%.

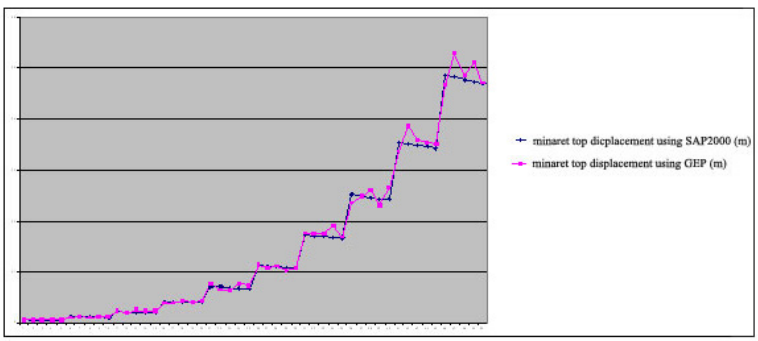

Figure5. Comparing the best model of gene expression programming and SAP2000 software in displacement of top of concrete minaret with diameter of 3 m.

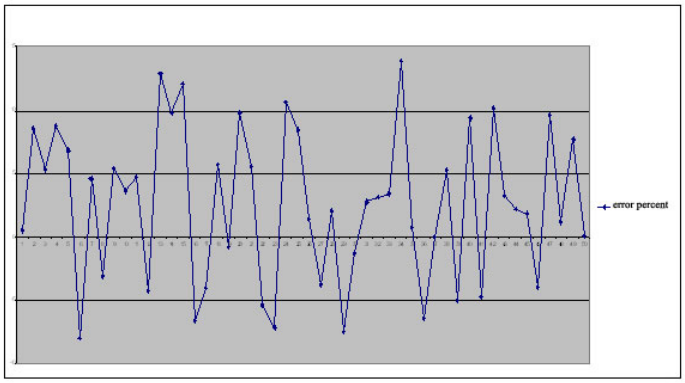

Figure 6. Comparing error percent of the best the best model of gene expression programming and SAP2000 software in calculation of displacement of top of concrete minaret with diameter of 3m

4. 4. Conclusion

The main goal of this study is to propose GEP as an alternative method of dynamic analysis of concrete minarets. For this purpose, GEP and a traditional calculation method, SAP2000, were compared. According fig.8, the results show that because the results of comparing error percent in gene expression programming (GEP) models are acceptable as compared with SAS2000 software, so using mentioned parameters, we can use gene expression models in determination of displacement of top of concrete minaret.

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6. References

[1] A.Jvadi, Iran architecture, 1st print, (1984). Mojarrad press.

[2] Ferreira, C., Gene Expression Programming a New Adaptive Algorithm for Solving Problems, Complex Systems, (2001), 13(2):87-129.

[3] Ferreira, C, Gene Expression Programming Mathematical Modeling by an Artificial Intelligence, (2002) , Angra do Heroismo, Portugal.

[4] Hanifi Binici, Cafer Kayadelen, Ismail H.Cagatay, Mostafa Tokyay and Hasan Kaplan , Gene Expression Programming for Prediction of Heat of Hydration of the Blended Cement, Scientific Researches and Essay. Vol.4 (3), (2009), PP. 141-151.

[5] Jung HC and Jamshid G, Genetic Algorithm in Structural Damage Detection. Computer Struct, (2001), 30:1335-1353.

[6] Halil Sezen, Ramazan Acar, Aden Dogangum and Ramazan Livaoglu , Dynamic Analysis and Seismic Performance of Reinforced Concrete Minarets, Engineering Structures journal. 30(2008), (2008), pp: 2253-2264.

[7] SAP2000, Integrated Software for Structural Analysis and Design, (2006), California. Structures and Structures Inc.

[8] Subasi.A, Yimaz AS, Binichi.H , Prediction of early heat of hydration of Plain and blended cement using neuro-fuzzy modeling techniques, Expert System, (1993).

[9] Yeh IC , Modeling of strength of HPC using ANN, Cement Concrete Res, (1998), 28:1797-808.

[10] Zadeh LA, Fuzzy Sets. Information and Control, (1965), 8:338-353.