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Investigation of the environment around the deep of Shahid Baqdrat underpass in Kerman due to changes in the mechanical properties of soil and water pumping and its prediction in artificial neural network

M. B. Soltani[1], M. Moemeni Raghabadi[2*], O. Tayari[3]

Abstract

During the construction of underpasses that are located below the subsurface water level and require deep or semi-deep excavation, the biggest problem is the existence of underground water, which interferes with the implementation of the project. Due to this problem, various methods were investigated in the underpass project of Shahid Baqadra city of Kerman to reduce the subsurface water. Finally, according to the valid scientific evidence and documentation, the use of a pumping well and directing it to the predicted place for emptying and stabilization of the pit with nailing was approved. In this research, numerical modeling of the underpass of Shahid Bakhodre city of Kerman was done with the help of finite element method using Plaxis2D software, and by changing the parameters of the mechanical characteristics of the soil, including the angle of internal friction, adhesion and permeability coefficient of the soil, as well as the output pumping flow rate in the software, the amount of settlement The maximum vertical around the edge of the pit was calculated and the necessary analysis was done in this regard. Then, by using artificial neural network of multilayer Proceptron in MATLAB software and Plexis software data as the input of the network, the settlement values of the environment around the pit have been predicted in other situations. The results showed that increasing the internal friction angle and soil adhesion and permeability coefficient decreased the settlement and increasing the pumping flow rate increased the soil settlement, but increasing the soil internal friction angle has a greater effect on reducing the settlement than increasing the soil adhesion. Finally, the artificial neural network has been obtained with the correlation coefficient value of neural network output and modeling output of 0.982, which shows the accuracy and power of accurate prediction of real values; Therefore, the matching of the two methods of numerical modeling and prediction by the trained artificial neural network shows that the predictions of neural networks can be trusted in engineering projects.

Keywords: *water pumping; Excavation; nailing; subsidence , Numerical modeling*

[1] PhD student in civil engineering, Islamic Azad University, Kerman
[2] Member of the Faculty of Civil Engineering Department, Islamic Azad University, Kerman
[3] Member of the faculty of water engineering department, Islamic Azad University, Kerman
*** Corresponding Author**

Extended Abstract:

1. Introduction

One of the most important issues in the construction of structures is the protection of pits and existing buildings in its vicinity. If proper pit protection methods are not followed, it will lead to irreparable financial and human losses and the risks caused by possible settlements and reduction of carrying capacity and the dangers caused by possible settlements and reduction of bearing capacity and lateral displacement will cause cracks in the structures adjacent to the pit. Considering that in recent decades, the need to solve traffic problems has increased in big cities, due to the great depth and exposure to underground water, which increases the pore water pressure and weakens the shear resistance parameters of the pit, the reliability factor is challenged. One of the construction projects in Kerman city that is under the shadow of this issue is the Shahid Baqodrat underpass project, which according to the project conditions, investigated the current state of soil stratification, permeability and subsurface water level, and to solve this problem, different drainage methods were used with the aim of lowering the water level and collecting They are stated in the project and finally the best option for implementation is suggested.

Today, in areas where the subsurface water level is high, it is necessary to lower the water level temporarily or permanently, which is called drying, that is done by pumping-drainage methods or a combination of the above methods. This action can continue by keeping the subsurface water level low until measures such as concrete works and the implementation of the foundation and retaining wall or the protection of the foundation of the adjacent buildings are finished... This type of dry construction is acceptable if a full investigation of the relative feasibility of this method is done in terms of damage to the neighboring effects of the project; because this method may cause settlement in nearby structures. When pumping from a well, water moves from the aquifer layer into the well and the water level inside the well and the piezo metric static level around the well start to go down. The amount of static level drop with piezo metric at any point compared to the initial state of water level drop is called. The longer the duration and amount of pumping, the more its drop will be.

Over the years, many methods have been developed to predict the settlement of shallow and deep foundations. However, methods for making such predictions with the necessary degree of accuracy and consistency have not yet been developed. Accurate prediction of settlement is essential because settlement, rather than bearing capacity, generally controls the design of the foundation. Artificial neural networks are used in an attempt to obtain more accurate settlement predictions.

Due to solving the problems of artificial neural network training, they have become the most powerful machine learning tool in the last decade. Neural networks originate from the human brain and these tools can be used in any part of machine learning, including supervised, semi-supervised or unsupervised learning. The purpose of using machine learning in this research is to predict the maximum amount of soil surface settlement. Therefore, in the present study, artificial neural network was used for regression, and PLAXIS software was used for simulation and data acquisition. Since the objective was regression, the multilayer perceptron (MLP) neural network was used. This type of network is a supervised learning-based network, so it requires initial and labeled data for training, for which a database of 120 simulation examples is prepared.

2. Materials and methods

PLAXIS is a software that is used for the analysis of stability deformation in geotechnical engineering projects. In this method, which is known as numerical modelling. The geometry of the problem is divided into a number w beans of elements that are connected at nodal point and determine the stress strain relations by appropriate equations and compatibility relations governing the problem. In the underpass of the mighty Shahid Baghodrat according to the investigations, 4 boreholes with a depth of 20 meters were dag to identify the stratification and texture of the soil in the place that the boreholes are machine - drilled. Based on the relationships and principles of the plan, in order to reduce the water level, some points were identified and finally, according to the water stagnation level and sufficient space for the installation of machinery, the best places were selected for drilling to wells. It should be noted that according to the investigation and the excavation, the water level is at a depth of 7.5 meters from the ground, which should be reduced to as 2.5 meters in order to carry out construction operations. Under the passage of Shahid Baghodrat excavation width is 20 meters and excavation depth is 5.9 meters. The subsurface water level is 2 manors above the on excavation floor, and in order to lower the subsurface water, 2 Wells have been constructed at a depth of 13 meters from the ground level. It should be mentioned that the project is from the North side to the street with medium traffic and its surface loads. 10 FHWA A 3-story building, which according to the regulations is 30 and on the south side is a street with medium traffic and a 2-stary building with surface loads 10 and 20. To model the wall, the plate element and the nailing plate element are used. The design is done in two dimensional form by assuming plane strain conditions with plaxis 2D finite element software. After obtaining the results from the modeling obtaining done in plaxis software. The results were analyzed and evaluated using an artificial network produced in Matlab software in order to predict the results of other similar cases and a neural network model artificially produced. The purpose of producing an artificial neural network is to predict the amount of settlement of the edge of the parameters and adhesion, the angle of internal firiction and the permeability of different sails, which is designed by obtaining the maximum settlement of the edge of the pit and using Matlab software and creating and artificial neural network model for predicting the land surface settlement. The main purpose of this research was to investigate the settlement of the edge of the pit by changing the parameters of soil shear strength and soil premeability and water pumping for this purpose, soils with adhesion rate of 20,30,40,60 Kpa and internal friction angle of 12, 20, 30, 35, 40 degress were modeled and studied.

For each of these soils, two states with a pormeability? Coefficient of 0.5 and 1 M/day have been considered. The pumping evaluated in this research is 1, 2 and 4 cubic meters per day. Deep network is used in this research. Considerning that the problem are four variables, which includes Soil ad hesion C, sail intermal friction angle p, discharge q. The coefficient of soil permeability is K. Therefore, four hidden layers have been considered. The output of the Network returns a value that is maximum amount of sitting per input.

3. Results

The obtained results show that by increasing the coefficient of permeability and adhesion and the angle of internal friction, the settlement of the soil decreases and also with the increase of the pumping flow rate, the settlement increases, and finally, the comparison between the neural network trained in this research and the numerical modeling shows that both have good validity, and neural networks can be optimally used in engineering projects.

4. Conclusion

In this research, the results obtained from PLAXIS software and the effect of adhesion parameters, internal friction angle, soil permeability, and pumping flow rate of standing water around the pit due to the construction of Shahid Baghodre underpass in Kerman city, and based on the data for the production of multi-layer perceptron artificial neural network in MATLAB software Was used.

1) In a situation where the pumping flow rate increases, the amount of settlement increases and also; causes an increase in operational costs; But at a certain flow rate, increasing the angle of internal friction has a greater effect on reducing soil settlement than increasing adhesion.

2) Increasing soil adhesion reduces settlement. The simultaneous effect of increasing soil adhesion and soil internal friction angle on the reduction of settlement is faster, and with the simultaneous increase of soil adhesion and internal friction angle, the amount of soil settlement decreases faster.
3) As the internal friction angle of the soil increases, the amount of soil settlement also decreases, which is due to the increase in the conflict between soil particles. If the internal friction angle and soil adhesion increase simultaneously, the amount of settlement should also decrease, but the speed of this decrease is lower.
4) As the permeability coefficient increases, the settlement increases. After examining the settlement changes for different permeability coefficients of the soil, it can be seen that, in general, with the increase of the permeability coefficient, the soil settlement decreases. The effect of the permeability coefficient is less pronounced in higher adhesions and has less effect on reducing settlement, while in lower adhesions, it leads to more settlements. Also, the effect of permeability coefficient on soil settlement decreases with the increase of internal friction angle.
5) The multi-layered perceptron artificial neural network was able to predict the results of the real values, and according to the correlation coefficient of the output of the neural network and numerical modeling, which was 0.982, it shows that a correct and reliable relationship has been obtained from this trained neural network.
6) The comparison made between the neural network trained in this research and numerical modeling shows that both methods have good validity and neural networks can be optimally used in engineering projects.
7) Based on the results obtained from numerical modeling, it can be seen that increasing the internal friction angle of the soil has the greatest effect on reducing soil settlement; After that, the increase in soil adhesion has a greater effect than the two parameters of flow rate and permeability coefficient. Finally, the drying flow has a greater effect than the permeability coefficient.

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