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Evaluation of Nailing Method Based on Scheduling and Economic Factors with Other Methods of Soil Nailing

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Abstract:

In construction workshops, excavation is one of the necessary operations that in some cases causes an accident at the workshop site. An accident such as a drift of the ground, a fall and, if excavated in urban areas, it may destroy buildings adjacent to the excavation, so as to avoid possible dangers of excavation, structures called retaining structures are used. Launching excavation operations requires the use of arrangements during, before and after work that can be used to prevent incidents.

In this research, in the beginning it has been tried to introduce the common methods of excavation and retaining structures in general. In the following, an overview of each of the methods is presented and their advantages and disadvantages are examined technically and from the engineering perspective.

Finally, according to researches and studies, we concluded that due to the possibility of concurrency and applicability for a variety of soils, soil protection by Nailing method compared to other common methods is currently one of the best methods in terms of time and economics to protect excavations with a high depth.

The results of the study show that the frequency of Nailing method in deep excavations has the most average than other protection methods in terms of Scheduling and economic factors and according to t test all hypotheses are valid.

Analysis of the first to sixth hypotheses showed that the Nailing method currently used in the statistical population designated for this research is the most economical method for protecting the excavation, given that the lowest score in the Scheduling variable is 10 and the highest score is 24, the average score obtained in this variable were 14.13 and their standard deviation was 3.56. For Scheduling, regarding the sensitivity of the tested excavations to accelerate the protection of the excavation walls to prevent the inevitable dangers of the wall, The Nailing method is also pioneering in comparison with other methods.

In the case of economic factors, the lowest score in the economic variables is equal to 22, and the highest score in the variable is 40, the average score obtained in this variable is 29.80 and the standard deviation is 29, consequently In terms of economic factors, Nailing is effective.

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Key words: excavation, soil protection, retaining structures, nailing

Introduction

In recent years, the depth of excavation has increased with increasing density and number of floors and the need to provide parking and other service levels in buildings, especially in the central cities. But in most cases, the same traditional methods used in the low depths excavations are used. Unfortunately, many still think that putting into place the necessary safety measures in excavation is cost and time-consuming, while excavation is considered to be a complex and very dangerous engineering task, and in particular, in more deep excavations, it requires In-depth reviews, precision and oversight, and ultimately spending considerable time and money so that people's lives and property are not compromised in this way. Nonetheless, ignorance of technical principles, negligence or irresponsible profiteering leads to an accident. In this paper, the elements to be addressed in the retaining structure, as well as the safety issues that need to be anticipated during design and execution, as well as the instructions previous, during and after the excavation and implementation of the retaining structures and safety issues related to the excavation workshop, as well as the duties and responsibilities of the agents involved in the construction excavation projects and the relevant laws and regulations, and the methods of recycling debris and saving the injured during the fall of the excavation are examined. It should be noted that if the excavation wall stays stable after the excavation, there is no reason to remain stable in the following days or even hours, as a result , excavation, firstly, must be done in the correct technical manner and in accordance with engineering and safety principles, and secondly If necessary, sufficient wall protection is required.

Excavation

Excavation is one of the construction activities that is carried out for various purposes such as demolition and excavation of a worn out building to rebuild, reach the ground level, protect the foundations against frost, build canals, underground reservoirs and parking.

Types of Excavation:

Excavations are divided into two general groups, supported or braced, unsupported or unbraced. It should be noted that in unsupported or unbraced excavations, the stability of slopes or vertical slabs in sticky soils is provided by soil mechanical conditions without any bracing.

Dangers in drilling and excavation:

1- Falling the walls and debris (the most important and most risky hazard in drilling and excavation environments).

2. Choking caused by oxygen deficiency

3. The risks of collisions and injuries to underground facilities such as gas, electricity, water, etc.

4. Toxicity due to inhalation of toxic vapors and gases

5. falling from the height

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The main goals of excavation support are:

1. Protecting the lives of people in and out of the excavation

2. Protecting property in and out of the excavation

3. Providing safe and secure conditions for the execution of work

signs of Hazardous excavation

The following is a sign of a hazardous condition and requires more comprehensive investigations and precautions:

A) Weak or sensitive adjacent building:

Examples include lack of skeletal system, weak wall mortar, and signs of poor performance of the building, the presence of cracks and fractures, or wall settling and Deformation. The existence of a common wall between the building to be destroyed and its adjacent building can often be a source of trouble. In some cases, the adjacent building has historical and cultural value and any settling can cause irreparable damage to it. In some cases, the adjacent is leaned to the building to be destroyed, and with destruction, it is possible that the adjacent building is collapsed without any excavation. Keep in mind that the weakness of the adjacent building only increases the troubles and the necessary precautions of the owner and the people who work in the various stages of the design and execution of the building, and does not make any excuse to ruin it. In other words, in courts that deal with the demolition of adjacent buildings due to construction activities, the building responsible person cannot avoid his responsibilities on the pretext that the adjacent building is weak, and in this case, the judge's answer to this is that you should apply more precautionary and protective measures in proportion to the weakness of the adjacent building.

B-Weakness of the soil:

Usually, the more the soil is weaker, there is a greater risk of excavation fall and destruction of adjacent buildings. Made ground is the most typical examples of weak soils. An explanation is that in the past, many of the places that are now inside Tehran were considered outside the city, and trucks carrying soil and rubbish unloaded there. Later, with the addition of these sites to the city, most of these soils and debris are leveling in the same place without engineering density, and now they constitute Made ground. In many cases, the site is also hill, Dale, or ravine and is leveled with soil or debris in a non-engineering way. In some parts of southern Tehran, especially in the 12th and 16th districts, there were some deep excavations in the past to provide bricks Raw materials, many of which are now filled with made ground. Young loose sediments, which often exist around the ravines and foot of the slopes, are also considered as weak soils. It is possible that the construction worker who is located near the land of the project site will not move the weak soil at the time of construction, and put the building on a loose soil. In this case, the adjacent building is stable as long as an excavation is not created next to it, but as soon as its

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surrounding is evacuated with even a shallow excavation, the weak soil below it will fall and cause the building to collapse.

C) Deepness

The more the depth of the excavation, the greater the risk of employees and nearby buildings. In recent years, with increasing construction density, the need for parking and storage and other common areas has increased and the number of underground floors has increased. It should be noted that as the depth of the excavation increases, the risk of falling is greatly increased, and if, in the past, in the shallow excavation, it was possible to excavate without comprehensive inspections and precise engineering plans and only by contracting with the excavation machine manager, with the presence of several workers, now with increasing depths and increasing the value of adjacent buildings and facilities, non-technical excavation is very dangerous and results in irreparable Human and financial losses.

D –Excavation opening duration

Usually, with the increase of the excavation opening duration, even if rainfall or atmospheric changes do not happen, the risk of falling is increased, but the increase in the amount of excavation opening duration, especially in the rainy season and in the humidity (winter and spring), is accompanied by heavy rainfall and flooding and Soil saturation or surfacerunoffincrease the risk of excavation falling, So that many fallings have occurred a few hours to several days after rain began.

E- Surface and Sub-surface waters

The high level of groundwater in the area usually requires tapping operation to lower the groundwater level. Usually high groundwater levels increase the risk of fall, especially after a few days of excavation and reaching groundwater level. Also, the existence of groundwater, throughburied Creek or aqueducts, can be very effective in increasing the risk of fall. Surface water flows are also factors that can cause excavation soil erosion and saturation, and help to increase the risk of collapse. Distancing existing or probable surface water (e.g. due to rainfall) is one of the most important and basic steps in the protection of excavation.

Retaining structure

The temporary Retaining structure is a soil structure which is constructed to prevent the fall of the walls, prevent the soil from drifting, and create the stability necessary for any horizontal movement of the walls, and the restraint of such movements, before any construction operations are undertaken. The Retaining structure on the one hand is related to the soil and various soil issues, which there should be comprehensive and complete knowledge of the problems and its characteristics and, on the other hand, it is a structure that should be designed and built according to well-known engineering principles to be able to withstand any drift, fall and horizontal movements of the soil through capability, Resistance and stability.

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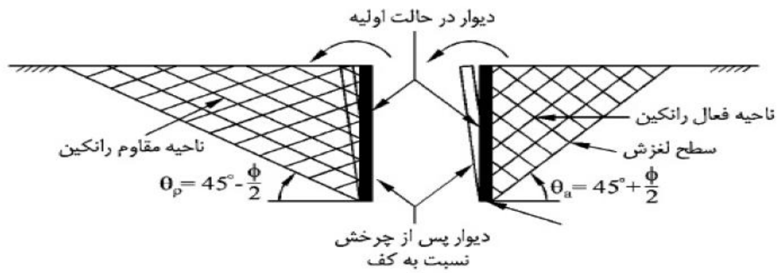

Figure 1: (The tendency of soils to fall inwards)

Types of stabilization methods

1 Anchorage

In this method, to prevent soil movement and drift, using special measures, the soil itself is used. First, we drill wells at a certain distance from the ground to be excavated. The depth of these wells is equal to the depth of the excavation, plus an additional amount for the concrete piles of the lower end of these wells.

2 nailing

This method is very similar to the Anchorage method. In this method, we also run drilling step-by-step and top-down. At each stage, with the help of special drilling machines, we drill Horizontal or inclined wells in the excavation wall. Then, we put pre-tensioned cables inside these wells and, by injecting concrete at the bottom of the well, we anchor these cables completely to the soil.

3 diaphragm wall

In this method, we first drill the retaining wall with the help of special drilling machines. Then simultaneously fill the drilled area with bentonite slurry and cement to prevent the soil from falling into the drilled area. Then, we place the shelves of the retaining wall reinforcements, which we have already made and prepared, inside the drilled area of the wall. Then we concrete the wall. Concrete used is often of a high quality concrete type.

4 Reciprocal anchorage

This method is suitable for low-depth excavations. In this method, we first drill wells on each side of the well, at certain intervals. The length of these wells is equal to the depth of the excavation, plus an additional amount of about 0.25 to 0.35 times the depth of the excavation. This added depth is in order to anchor the Lower end of the profiles placed in the well.

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5 Pile

In this method, we pile around the ground that is to be excavated at certain intervals. These candles can be of different types of structural materials such as steel, concrete and wood. Also, concrete piles can be Precast or Bored.

6 sheet pile

In this method, first we knock the sheet piles on the sides of the excavation and then start the excavation. Once the excavation has reached enough, we install the wales in the shafts of the shield and on them. Then connect the struts to the wales perpendicular to the sheet plate.

7 truss

This method is one of the most appropriate and most commonly used method of retaining structures in urban areas. Its implementation is simple and does not require much equipment and expertise, but also has a lot of flexibility in terms of implementation in different situations. . To carry out this type of retaining structure, we first drill wells at the site of the trusses struts adjacent to the excavation wall; the depths of these wells are equal to the depth of the excavation, plus some extra for the implementation of the lower end of the Truss pile.

What is the study of soil mechanics?

Soil Mechanics Studies perform local surveys on general geology, soil and groundwater characteristics, and in particular, the existence and depth of problematic soils, such as made ground. Technical recommendations on the type of soil, the permissible resistance of the soil, and the expected settlings and design parameters of the Retaining walls are the rest of the necessary parts of the soil mechanics report. Considering the depth of excavation required and the specifications of buildings and other nearby facilities such as passages, gas lines, sewage ... the risk of excavation and the method of excavation, the safety slope of the excavation, the steps of excavation, the need for the retainingwall, the type of retaining structure and The method of design and implementation should be considered. To do this, the specifications of the buildings and facilities adjacent must be considered in detail and presented in the report.

Nailing Method Introduction

The nailing method is based on leveling and the improvement of the existing soil mass by tyingthe soil mass by a series of steel brace at close distances. The use of Nailing method increases the shear resistance of the soil mass and restricts soil changes due to increased shear resistance at the slip surface due to the increase in vertical force as well as the reduction of slipping forces at a potential slip surface. The surface of the drilled Trench, which is levelled by nailing, should be protected using a shotcrete wire mesh.

Applications of the Nailing method

The stabilization of trenches in highway and railway construction projects

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- The system for the stabilization and temporary protection of excavations in urban areas for the construction of high-rise buildings.

-Stabilizationof work fronts in tunnels and underground structures

- Stabilizationof abutments adjacent to bridges

Feasibility study of nail walls

The feasibility study of nail walls includes a number of technical and economic considerations that include: (1) the assessment of general ground conditions; (ii) the estimation of the advantages and disadvantages of nail walls in specific cases; (3) comparisons with other systems (such as braced walls); (4) Cost Estimation. The following section covers the feasibility study.

Terms of use of nailing method

Nailing can be used in a wide range of soil types and conditions. Experience in projects has shown that If the condition of the land is desirable, the use of nailing will be more economical than other techniques. On the contrary, if the adverse conditions of the soil are ignored, the use of nailing method can cost more than other methods. Typically, the nailing of soil walls can be done under complicated layering conditions, provided that each of the layers in the soil section is made up of suitable materials.

Nailing system implementation steps

1- Excavation of the area with specific length, width and height in the vicinity of the excavation

2- Drill boreholes located in the excavated area on the excavation wall to create tensionbracing

3- Put the reinforcement in the middle of the borehole and Injection in the drilled borehole

4- Placement of surface or environmental drainage system

5- Installing the steel mesh on the nails with an appropriate overlap

6- Implementing shotcrete procedure on steel meshes

7. Installation of head nails

Research purposes

1. Study of different methods of stabilization of building excavations and its comparison with soil tying system (Nailing),

2. Selecting stabilization of the excavation in the Nailing method as a cost-optimal method

3- Selecting stabilization of the excavation in the Nailing method as Time-Optimal Method

4- Selecting stabilization of the excavation in the Nailing method as an Implementation Optimal Method

5- Achieving the main reasons for using nailing as an optimal and safe method than other traditional methods and unprotected systems.

Research hypotheses

The excavations seem to be deep and the excavation soil is inappropriate (made ground).

Nailing system is the most economical method known today.

Soil homogeneity assumption

Influence of technical and executive factors on Nailing system

In a theoretical research, Amir and Abdolhamid Mehrdad, 1394, Three-dimensional modeling of nailed walls: a case study of nailing project, International Conference on New Achievements in Civil Engineering, Architecture, Environment and Urban Management, Tehran, Institute of Modiran Ideh Pardaz Payetakht Vira, One of the most important problems in geotechnical engineering is the issue of stabilization of excavations. Nailing techniques are relatively new techniques for excavation stabilization in foreign countries and Iran. In this research, FLAC 3D software has been applied to numerical modeling of field nail wall. The steps of implementation of the Nailing field project has been done in numerical formulation to analyze the amount of deformation and tensions created in the wall. The amount of horizontal displacement of the wall in the current project is recorded using indicators that are installed in different locations and compared with the obtained numerical values. The results show an acceptable approximation between numerical and field results.

Research Methodology

In this paper, we analyze and interpret our chosen subject by data obtained by completing a questionnaire that is aimed at achieving the frequency of methods of excavation protection methods in Tehran and even the type of soil and recognizing the best way to reduce the hazards caused by excavation in Tehran and the questionnaire was answered by a number of geotechnical engineers, Nailing contractors and professionals in the excavation protection. Since we can use both manual and computer methods for data processing, we use computer method and SPSS statistical software to increase the accuracy and speed.

Findings

Shapiro-Wilk test were used to test the normal distribution of variables. The results show that the variables of economic factors, scheduling factors that have continuous distribution, and normal distribution are not statistically and significantly different and have normal distribution. The results of the Shaipro-Wilk test are shown in Table (1).

Table 1: Shapiro Wilk test results for main variables

result	sig	statistics	
confirm	0.38	0.821	economic factors
confirm	0.536	0.537	Scheduling factors

Friedman test (prioritizing the effect of variables)

Friedman test prioritizes different variables based on their average rankings using respondents and based on their assigned importance. It should be noted that in the present research, the goal is to determine the extent to which each of the variables is used, so any variable that receives a higher average rank will get a higher rank.

The results of Table (2) show that given the fact that the calculated significance level (0.000) is less than 5%, then the null hypothesis is rejected, that is, at least one pair of the averageranks of the Scheduling factors efficiency have a significant difference.

As shown in table (3), the faster Scheduling variables of soil protection operations (Nailing and Anchorage are first and Improvement of excavation Soil protection Operations faster than the schedule is in the second place and the average rank of excavation Operations Scheduling is 1.03 Which was ranked last.

Table 2: Prioritizing Scheduling factors

result	Error (%)	Significance level	DOF	Chi-square	number
null hypothesis rejection	0.05	0.000	4	151.46	45

Table 3: Prioritizing Scheduling factors (speed)

	mean	Standard Deviation	Average rank	Effectiveness rank
excavation operationsschedule	1.00	0.00	1.03	5
Improvement of soil protection operations according to schedule	2.33	0.56	2.84	4
Improvement soil protection operations faster than schedule	2.56	0.50	3.20	2
soil protection operation less than schedule	2.36	0.53	2.92	3
Faster Scheduling of Soil protection (Nailing &Anchorage)	51.31	35.27	5.00	1

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Prioritizing economic factors

The results of Table (4) show that given the fact that the calculated significance level (0.000) is less than 5%, then the null hypothesis is rejected, that is, at least one pair of the average ratings of the economic factors efficiency have a significant difference.

As shown in table (5), the faster Scheduling of soil protection operations variables(Nailing and Anchorage are first and Improvement of excavation Soil protection Operations faster than the schedule is in the second place and the average rating of excavation Operations Scheduling is 1.03 Which was ranked last.

Table 4: Prioritizing economic factors

result	Error (%)	Significance level	DOF	Chi-square	number
null hypothesis rejection	0.05	0.000	9	242.82	45

Table 5: Prioritizing economic factors

	mean	Standard Deviation	Average rank	Effectiveness rank
Cost of using skilled workers in the project	4.44	0.5	7.82	2
The cost of using specialized machinery	4.47	0.5	8.09	1
The cost of maintaining construction machinery	3.38	0.49	4.1	7
Timely payment to contractors	3.18	0.91	3.83	8
The cost of Building Materials to apply the present methodology in this project	4.07	0.54	6.6	5
Estimation of cost of executive operation unit and its analysis based on wages	3.8	0.4	5.63	6
Cost control and management	4.07	0.54	6.61	4
Lack of funds to complete the soil protection stage	2.51	0.69	2.26	9
Waste management costs for collecting materials during excavation	2.78	0.42	2.6	10
Minimum cost in excavation protection method	27.09	29.29	7.44	3

Investigating the effective Scheduling factors on Soil Stabilization Methods

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Table 6 shows the status of each of the variables related to the Scheduling by frequency distribution and the median and mean index. The following variables have been used to examine this relationship.

1. excavation operations schedule
2. Improvement of soil protection operations according to schedule
3. Improvement soil protection operations faster than schedule
4. soil protection operation slower than schedule
5. Faster Scheduling of Soil protection (Nailing & Anchorage)

Table 6: Frequency distribution of scheduling factors

rarely	no	yes	median	Standard Deviation	mean	
0	0	1	1	0.00	1.00	excavation operations schedule
13	22	10	2	0.72	2.07	Improvement of soil protection operations according to schedule
17	28	0	2	0.49	2.38	Improvement soil protection operations faster than schedule
13	27	5	2	0.61	2.18	soil protection operation less than schedule

Investigating the Effective Economic factors on the Implementation of the Nailing Method

Table 7 shows the status of each of the variables related to economic factors by frequency distribution and the mean and median index. The following variables have been used to examine this relationship.

Table 7: Frequency distribution of economic factors

Very high	high	medium	Low	Very low	Median	Standard Deviation	Mean	
20	25	0	0	0	4	0.50	4.44	Cost of using skilled workers in the project

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21	24	0	0	0	4	0.50	4.47	The cost of using specialized machinery
0	17	28	0	0	3	0.49	3.38	The cost of maintaining construction machinery
5	8	22	10	0	3	0.91	3.18	Timely payment to contractors
8	32	5	0	0	4	0.54	4.07	The cost of Building Materials to apply the present methodology in this project
0	36	9	0	0	4	0.40	3.80	Estimation of cost of executive operation unit and its analysis based on wages
8	32	5	0	0	4	0.54	4.07	Cost control and management
0	5	13	27	0	2	0.69	2.51	Lack of funds to complete the soil protection stage
0	0	35	10	0	3	0.42	2.78	Waste management costs for collecting materials during excavation

Research hypotheses test

In this section, the researcher uses appropriate statistical tests to test hypotheses and assess their validity.

The scheduling factor affects the Nailing method.

H0: The scheduling factor does not affect the Nailing method.

H1: The scheduling factor affects the Nailing method.

As shown in Table (8), the mean of scheduling factor and standard deviation are 80.17 and 63.40, respectively. The t obtained was 8.48 and the significance level was 0.000,

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considering the significant value, the t value is statistically significant, so this hypothesis is confirmed.

Table 8: one sample t test

Mean of Standard Deviation	Standard Deviation	Mean	Number	
9.45	63.40	80.17	45	Scheduling factor

Table 9: one sample t test for scheduling factor affecting Nailing method

Confidence intervals at the probability level of 95%		Mean difference	Significance level	DOF	T	
upper bound	Lower bound					
99.22	61.12	80.17	0.000	44	8.48	Scheduling factor

The economic factor affects the Nailing method.

H0: The economic factor does not affect the Nailing method.

H1: The economic factor affects the Nailing method.

As shown in Table (10), the mean of economic factor and standard deviation are 59.77 and 30.63, respectively. The t obtained was 13.09 and the significance level was 0.000, considering the significant value, the t value is statistically significant, so this hypothesis is confirmed.

Table 10: one sample t test

Mean of Standard Deviation	Standard Deviation	Mean	Number	
4.56	30.63	59.77	45	economic factor

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Table 11: one sample t test for economic factor affecting Nailing method

Confidence intervals at the probability level of 95%		Mean difference	Significance level	DOF	T	
upper bound	Lower bound					
68.90	50.57	59.77	0.000	44	13.09	economic factor

The results of this study showed that the frequency of nailing method in deep excavation is the highest than the other methods in terms of safety, scheduling and economics, and all hypotheses are valid according to the T test method. Analysis of the six hypotheses showed that The Nailing method has now been identified as the most economical method for excavation protection in the statistical population designated for this study. In terms of scheduling, due to the sensitivity of the tested excavations to accelerate the protection of excavation walls and to prevent the inevitable risks of wall fall, the Nailing method is pioneering in comparison with other methods.

Conclusion

1. Different methods of building excavations stabilization have been investigated and according to analyzes and studies, the Nailing method is more frequent than other methods.

2- In terms of scheduling, Nailing method is faster than other methods of protection.

3- Excavation stabilization by Nailing method as an optimal cost and efficient method

4. The results of the study indicate that the frequency of the Nailing method in deep excavation is the higher than other protection methods in terms of safety, scheduling and economics, and all the hypotheses of the T test are valid.

Analysis of the first to sixth hypotheses showed that the Nailing method is currently used in the statistical population designated for this research as the most economical way for excavation protection.

5- The lowest score in the scheduling variable is 10, and the highest score in this variable is 24, the average score obtained in this variable was 14.13 and the standard deviation was 3.56, in terms of scheduling, according to the sensitivity of examined excavation to accelerate the protection of excavation walls to prevent the inevitable risks of wall fall, the Nailing method is is pioneering in comparison with other methods.

6. In the case of economic factors, the lowest score in economic variables is equal to 22, and the highest score in the variable is 40, the average score obtained in this variable is 29.80 and the standard deviation is 29, As a result, in terms of economic factors, Nailing is effective.

Research suggestions:

It is recommended that, prior to launching the excavation operations, to accelerate the soil protection operations during excavation and to reduce the risks of soil pressure and potentialfactors, after field surveys and the preparation of urban facilities maps, we obtain adequate information on the type of construction and the number of floors of adjacent buildings to further identify the excavation site and potential hazards, in order to anticipate and implement a suitable method for preventing irreparable human and financial losses, and launch excavation project with comprehensive planning and management In the shortest time and with the lowest risk percentages, and for deep excavations In particular, in the urban areas (such as Tehran), it is necessary to use soil nailing operations according to the type of soil in order to lower cost and increase safety and the speed of the operation. As observed in the present study, Nailing method is now the most effective method for protecting the deep excavations walls in the city of Tehran according to the project hypotheses.

References

1. The Office of Labor Inspection and the Ministry of Cooperatives, Labor and Social Welfare
2. Principles of excavation and retaining Structures - Office for the Development and Promotion of National Building Regulations
3. Principles of excavation and retaining Structures - Office for the Development and Promotion of National Building Regulations
4. Association of Geotechnical Engineers of Iran, Practical Workshop on Reinforcersin Road Construction - March 2015
5. Protective regulations of construction workshops approved by the Supreme Council for Technical Protection and the Ministry of Cooperatives, Labor and Social Welfare
6. Protective regulations of construction workshops approved by the Supreme Council for Protection and the Ministry of Co-operation, Labor and Social Welfare
7. Behrouz Gatmiri - 1394- Quarterly Journal of Geotechnical association of Iran
8. Behzadian, Amir Reza and Mohammad Nowroz Olyaie, 1395, the effect of overhead pressure on the resilience of nail pulloutusing the finite element method, Second National Conference on Civil Engineering, Architecture and Urban Development, Babol, Koma Research Institute
9. Behzadian, Amir Reza and Mohammad Nowroz Olyaie, 1395, Investigation of the Dilation behavior of the interaction zone between the nail and the soil in nail pullout, Second National Conference on Civil Engineering, Urban Architecture and Development, Babol, Koma Research Institute
10. Hamed mirJafari, Behrooz; Babak Vazirinezhad and Atefeh Mir Jafari, 1395, How to deal with the narrow interstitial soil masses in urban retaining structures , An Executive Case Study, the International Conference on Civil Engineering, Architecture and Urban Landscape, Turkey, the Istanbul University, Constant Permanent Secretariat, Istanbul University
11. Protection against soil collapse in excavation operations in plain language, Jahad University Press, Saeed Nazari-Najmeh Karami, 1392
12. Construction excavationExecutive instruction approved by the Council for the National Building Regulations
13. Construction excavation Executive instructions approved by the Council for the National Building Regulations

14. Dr. Carlos Laseret - Engineer Victor Elias - Dr. R. David Spinoza - Dr. Paul J. Sabatini, FHWA Regulations (Soil nail wall) -SOIL NAILING WALLS
15. Ali Fathi Ashtiani, Psychological tests, Tehran: Bethat, 1389, ISBN 9786005116274
16. Twelfth Section of National Building Regulations
17. Twelfth Section of the National Building Regulations (Safety and Work Protection during Operation)
18. Najafvand, Shahriar, Hossein Mohammadi and Jalal Kasebzadeh, 1395, Optimizing and increasing the safety of excavation's Stability Using Reliability Analysis, 2nd International Conference on Research Findings in Civil Engineering, Architecture and Urban Management, Tehran, International Federation of Inventors' Associations (IFIA), Applied science University
19. Bowles; J.E. (5 edition) 'Foundation analysis and design'
20. Clayton; et al, " Earth pressure and earth - retaining structures "
21. David Spinoza, Victor Eliseppy, Peljey Sabatini, Carlos Laszarte-Collection of Soil Improvement Procedures: A comprehensive guide to the design and implementation of soil tying systems
22. FHWA (2003). Geotechnical engineering circular No.7-Soil nail walls.Report FHWAD-IF-03-017, V> S> Department of Transportation, Federal Highway, Washington D.C.
23. Foundations, Vol. 32, No. 1 pp. 59-70. 11
24. Given, Lisa M. (2008). The sage encyclopedia of qualitative research.methods.Los Angles, Calif: Sage Pablications
25. Guide to Soil Nail Design and Construction, Geotechnical Engineering office, Civil Engineering and Development Department of the Government of the Hong Kong Special Administrative Region.
26. HILL, R.L., 2006. "The Impact of Fly Ash on Air-Entrained Concrete," High Performance Concrete Bridge Views, # 43, National Concrete Bridge Council, Skokie, IL.
27. Hong, Y., Chen, R, Wu, C., Chen, J. (2005), "Shaking Table Test and Stability Analysis of the Steep Nailed Slopes." Canadian Geotechnical Journal
28. http://www.ibm.com
29. http://www.spss-iran.com/index-files/Azmoons.htm
30. ISSMFE - Tc 17, (2004), " Soil Nailing ", Technical Report
31. Juran I., Gerge B.Khalid F. and Elias V. (1990a): -Kinematical Limit Analysis for Design of Soil Nailed Structures‖, J. of Geotechnical Engineering, ASCE, Vol. 116, No. 1, p. 54-71.
32. Juran I., Gerge B.Khalid F. And Elias V. (1990b): -Design of Soil Nailed, Retaining Structures, Design and Performance of Earth Retaining Structures‖, J. of Geotechnical Engineering, ASCE, Vol. 116 pp. . 54-71.
33. Kramer, S.L. (2005). -Geotechnical Earthquake Engineering‖, Pearson Education, Singapore.
34. Lazarte, C.A., Elias, V., Espinoza, R.D. and Sabatini, P.J. (2003). -Geotechnical Engineering Circular No. 7 -Soil Nail Walls‖,
35. MacKenzie CPD 93, id. BSOAS XXXI 2 1968 252, Hubschmann PSt 41, Mayrhofer KEWAI400
36. Matsui, T. and San, K.C. (1992). -Finite Element Slope Stability Analysis by Shear Strength Reduction Technique‖, Soil a nd
37. Report FHWA0-IF-03-017, Federal Highway Administration, U.S. Department of Transportation, Washington, DC, U.S.A. 10
38. Nailing for Stabilization of Steep Slopes near Railway Tracks, Prepared by Dr. Amit Prashant, Ms. Mousumi Mukherjee, Department of Civil Engineering Indian Institute of Technology Kanpur, Submitted to Research Designs and Standards Organizations (RDSO), Lucknow
39. Soil Nailing Technical Report IS SMFE-TC 17,2004
40. US Army Corps of Engineering, " Retaining and flood walls "
41. Wikipedia contributors "scientific method" Wikipedia, The Free Encyclopedia, (accessed December 3, 2009)

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