Journal of Civil Engineering Researchers

J-Researchers

JOURNAL OF CIVIL ENGINEERING RESEARCHERS

Introducing soil nailing and anchorage as common methods of stabilization of pits

Ehsn Sarooghi Farahani [a,*]

[a] *Iran University of Science and Technology, Iran*

Abstract

In this article we intend to explain about nailing and anchorage as conventional methods of stabilization of deep pits and in the following the implementation methods of each one's will be explained and we will understand that these two methods are very effective to restrain against earth lateral pressure and in some cases a combination of these methods is too practical.

Keywords: nailing, anchorage, earth's lateral pressure , excavation , stabilization ;

1. Introduction

Generally by increasing population density in urban areas and necessity of maximum uses of land's capacity leads to deep excavations that should be stabilize by some methods that here in this article we notice to nailing and anchorage for stabilization of earthen walls against the lateral pressure [1].Soil nailing is a technique to reinforce and strengthen ground adjacent to an excavation by installing closely spaced steel bars called "nails" [2]. It is an effective and economical method of constructing retaining wall for excavation support of hill cuts and bridge abutments and highways [3]. The nails are subjected to tension and compression shear and bending moment. In nailing at first holes are drilled on earthen walls then steel bars or strands with different diameter placed in them and all of the holes in nailing and a part of that in anchorage method will be full by grouting [4].

The difference between these two methods is that in anchorage we pre-stressing the bars or the strands

* Corresponding author.: e-mail: Ehsan_frhni@yahoo.com

and make a tensioning force to deal with large deformations in earthen walls and keep safe the pits and the environment during the construction process [5] .

2. The advantages of using nailing

The using of soil nailing method lead to:

1. Increase in Shear strength of the soil mass
2. Limitation and controlling the soil deformations in effect of
   increase in shear strength on slip surface because of increasing the vertical forces.
3. Decrease in slip forces on failure surface.

Generally stabilization by nailing and anchorage method is very similar to each other [Fig1] and [Fig2]

Fig.1 stabilization of earthen wall by nailing method

Fig.2 stabilization by a combination of nailing and anchorage method

3. Classification

3.1. Nailing and implementation method

In soil nailing method at first we should excavate 1 to 2 meters according to ability of soil mass to remain stable without inhibition for the time about 24 to 48 hours of course we should bear in mind that the width of excavation Would be sufficient to be install the drilling equipment [Fig 3] .

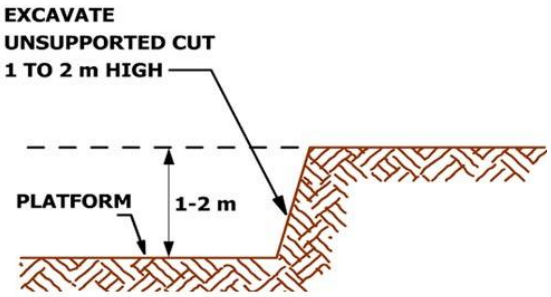

Fig 3. Excavation unsupported cut

Drilling the holes to installing the nails that the nails are with different length, diameter, direction and certain distances [Fig4].

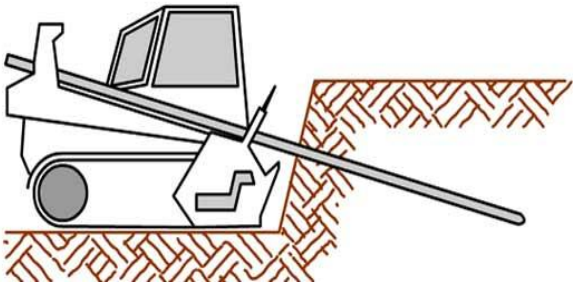

Fig 4. Drilling the holes to installing the nails

Installing the nails and grouting the holes : the nails install into the holes and they are usually solid . to be surrounding the nails by grouting we use spacer along the nails and it uses to keep certain distance between nail and soil. Injection tube send into the holes concurrently and the holes will be grouting by that, grouting is done by full pressure and excavation is done in middle parts which nails installed and the drainage rolled tapes remain in the toes of excavation

and then the surface of the earthen wall to prevent erosion and preserve the integrity in nail's performance cover by a temporary facing named shotcrete [Fig 5] .

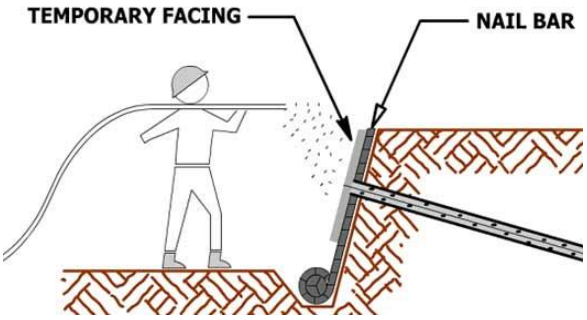

Fig 5 .Installing the nails, injection grouting and shotcrete facing

shotcrete facing and installing the bearing plate : in this step after all of the operations of nailing we install a mesh bars with a small diameter under the permanent coverage and the geo composite tapes installed on them to drive the water into the earthen walls to outside and also after this to creating a complete connection of nails to wall's surface and to avoiding punching we install bearing plate on the wall and close the nail by a nut and create a pretention force on that and then we can implement the permanent cover by thickness of 10 to 15 centimeters and also we continue all the above steps be the time we arrive to intended height [Fig 6].

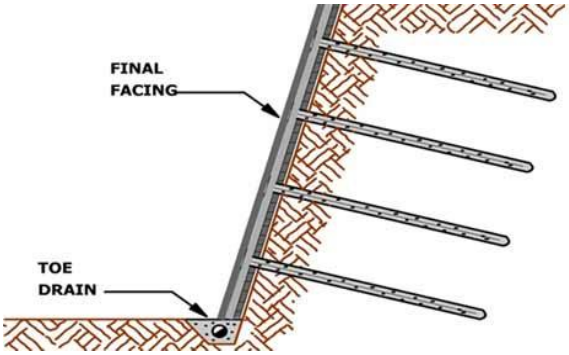

Fig 6 . Final step of nailing installing the bearing plate

Generally if we want to summarize steps of nailing method we can show it in following [Fig 7]

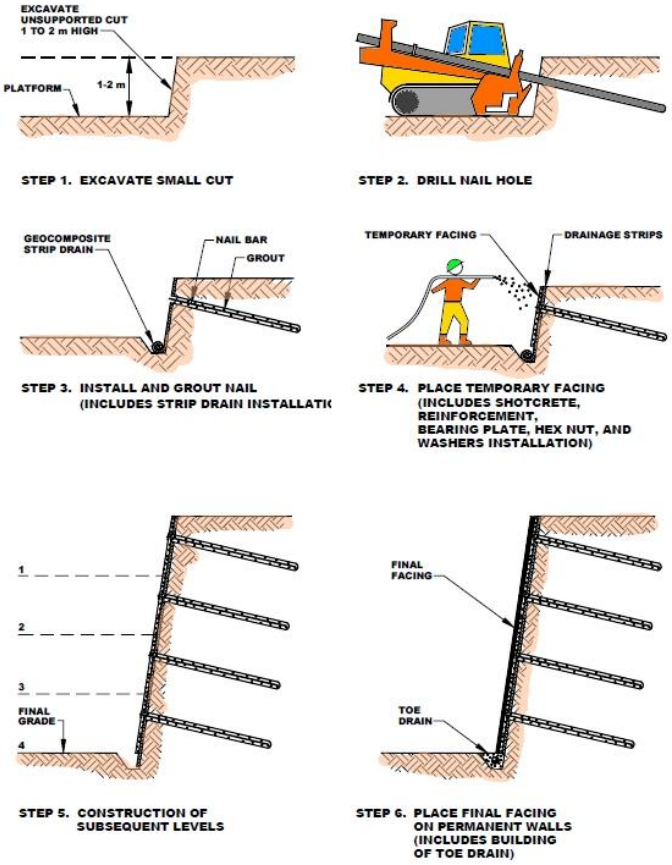

Fig 7. The complete steps of nailing method

3.2. Anchorage and implementation method

3.2.1. Mono bar anchorage

It is completely similar to nailing method with difference that in this system with a special mechanism the front part of the nails or bars don't inject by grouting until by stretching the front part the bar we can prevent the movement of earthen walls , in this method when the bars install into the holes the parts that doesn't need to injecting grout is covered by a sheath and after grouting the loaded bar after arriving to 7 days strength of grout is drawn by hydraulic jacks [Fig 9]. Generally we can say that anchorage have two separated pars bonded and un-bonded parts as we can see in the [Fig 10].

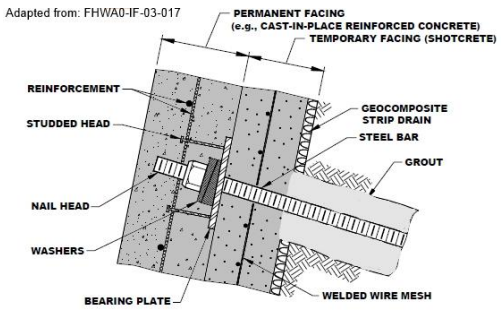

Fig 8. The nails and nuts of the nailing

Generally in nailing and mono anchorage method we have steel nails or strand that install into the holes as you see and the bearing plate and the nuts close at the end of them on the earthen walls to withstand against soil lateral pressure [Fig 8].

Fig 9. Hydraulic jack and the equipment of stretching the strand in anchorage method

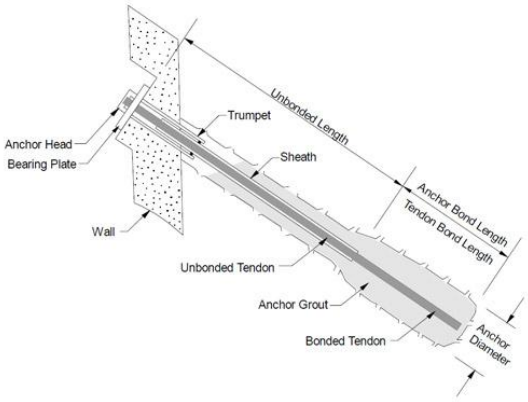

Fig 10. The construction of the anchor in the soil which consist of the bonded and un-bonded parts as it shown.

3.2.2. Anchorage with steel strand

Strands are consisting of the pre-stressed steel strand protecting against corrosion. Actually in this system using steel strand instead of steel bars to stretching them to create a pre-tensioning force to more resistance against lateral pressure of soil, the strands system can be mono or multi strands [Fig11].

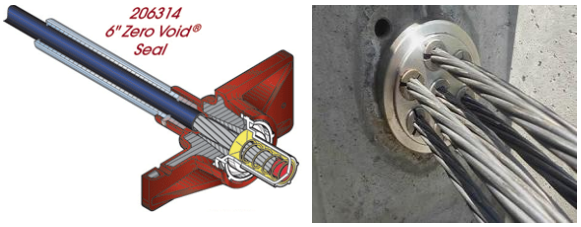

Fig 11. The mono steel strand and the multi steel strands shapes of the anchorage method.

3.2.3. Anchorage and implementation method

At first we should make ready the anchors to install and we explained that the anchors are consist of two bonded and un-bonded parts and it is necessary to install sheath on the bonded part to avoiding cohesion between anchors and grout then we should install spacers along the anchors that the first one of them should be at least in the 0.5 meter from the end of that. we should pay attention to this step that we should cleaning the holes by compressed air after drilling finished .cement grouting should be injected with the low pressure from at the end of the holes and also In order to remove the adverse effects

on the holes we start grouting for more times and we can control air discharging by sending an air tube simultaneous with injecting tube and in this way we can improve the stretching capacity of the anchors and after setting the injected grout the stretching operation starts to intended load and if we use multi strand we should stretch all of them concurrently [Fig 12] .

Fig 12. The steel strands installed and the grouting is done and the earthen wall should be cover by spraying concrete.

4. Conclusion

Actually in geology science and civil engineering it is proven that soil nailing method and anchorage method are the best method for stabilizing the pits and it is conventional and practical in the most construction projects because it is implemented step by step and after that every level finished the pit stabilized and keep safe during the next levels. Not occupying the environment and not disturbing other construction operations because they preferred to other methods. in most cases the combination of both nailing and anchorage are used to stabilized the pits. We should pay attention to some parameters when we are designing nailing such as soil type, adjacent buildings, groundwater level consist of surface water and groundwater.

References

[1] Carlos A. L., and Victor E., 2003. Geotechnical Engineering Circular NO. 7 Soil Nail Walls. FHWA, Maryland, Technical Report Documentation, FHWA0-IF-03-017.

[2] Sarnag Kh. F., 2010. The geotechnical report of Velenjak residential-commercial project. technical report.

[3] I. Juran, Behaviour and Working Stress Design of Soil Nailed Retaining Structures. Performance of Reinforced Soil Structures, British Geotechnical Society, 1990, 207–217.

[4] R.J. Byrne, D. Cotton, J. Porterfield, C. Wolschlag, G. Ueblacker, Manual for Design and Construction Monitoring of Soil Nail Walls, Report FHWA-SA-96-69R, Federal Highway Administration, Washington, 1998.