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Investigation of prestressed anchor retaining systems within the scope FHWA-99-015 and BS 8081:2015

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ABSTRACT

As a result of migration from rural to urban areas, city centers are developed and expanded. With the increase of need in the life and business centers need, the decrease in the solid soil to be built and the presence of structures close to being affected from each other geotechnically has been brought economic problems and made deep excavations obligatory. In this study, the examination of the prestressed anchor shoring systems, which is one of the deep excavation support systems, has been carried out in terms of design criteria defined in regulations. Regulations of FHWA-99-015 and BS 8081:2015 and the circular which is published by the Ministry of Environment and Urbanization on 31 August 2018 in Turkey have been taken into consideration for the stability criteria of deep excavation systems. Also, the limiting situations that should be considered in terms of the stability of the shoring system have been investigated in the design. General comparisons of the regulations and standards used in the design of the shoring system and recommendations are given.

Introduction

As a result of the Industrial Revolution that started in the 18th century, there has been intense population mobility from rural to urban areas. Due to the increasing needs in developing and expanding cities, more complex structures have been built and the necessity for complex structures in city centers has made deep excavations obligatory. In this context, geotechnical engineers undertake the mission of safety and economy of deep excavations.

It is known that there are three solutions to a geotechnical problem to be encountered in an engineering structure to be built;

- making changes in the land to be built,
- making concessions from the project and making it suitable for the land,
- soil improvement using Geotechnical Engineering.

Retaining systems are designed so that construction equipment and crews can work safely in the works to be carried out below the natural soil level. One of the deep excavation support systems used today is the prestressed anchor shoring system. They are implemented by gradually descending from the natural level of the ground, making the supporting walls or piles, passing the steel ropes through the drilled drills and filling them, subjecting them to pre-tension forces, and repeating these processes until the required working level.

Various regulations have been established by various institutions and organizations in the light of many years of observations, experiments, and experiences to carry out the applications without any problems. In our country, in the circular on "Excavation Safety and Precautions to be Taken" published by the Ministry of Environment and Urbanization on 31 August 2018, the issues to be taken into account in the implementations are specified. In this

circular, "The norms and standards to be taken into account for pre-stressed permanent and temporary anchors are as follows: "TS EN1537, DIN4125, BS8081, FHWA-IF-99-015".

When it is looked at the literature, it is possible to come across both theoretical and practical studies on prestressed anchor shoring systems. It has been emphasized that the need for deep excavation support systems has increased in urban centers with high populations and the determinants of the structural performance of the prestressed anchorage shoring systems used for this need and the changes that occurred after the application. In the studies, real-life applications of prestressed anchor shoring systems are included, as well as theoretical analyzes [1-4].

In this study, a brief review of the design criteria of prestressed anchor retaining systems has been presented by comparing international and national regulations and standards.

Material and Method

The purpose of the prestressed anchors, which is one of the deep excavation support systems, is to prevent the excavation from collapsing towards the excavation area and loss of life and property due to the stress changes in the soil as a result of the deep excavation. Its basic working principle is based on the fact that it works in adherence between the soil and anchorage bond by creating a friction force and providing stability. It is passed with free length up to the outside of the ground slip plane. After the displacement of the failure plane by the value found as a function of the excavation depth, the root part is transported. This system is shown in Figure 1.

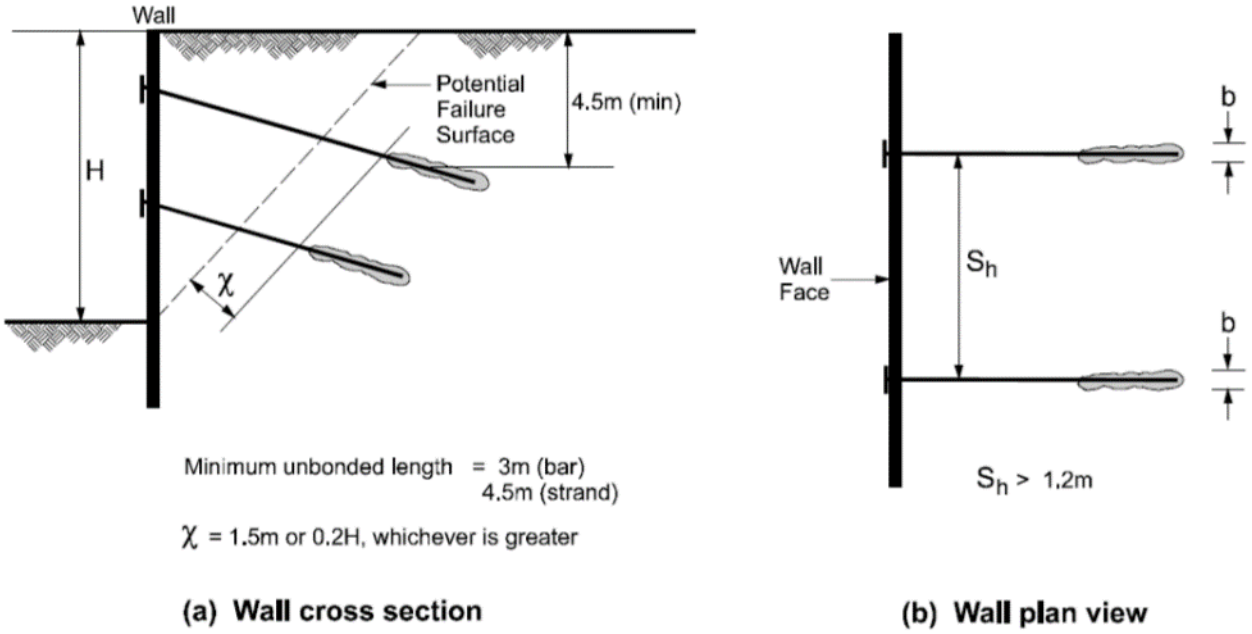

Figure 1. Cross-sections of the anchored system (FHWA-99-015) [1]

Anchors and Anchored Systems Scope FHWA-99-015 [1] and BS 8081:2015 [2]

It is seen that the anchors are structurally composed of three main parts (Figure 2.). Anchor head, free length, and anchor root form the general structure of anchors. Anchors are classified as permanent and temporary anchors according to their service life. The anchors to be used for the period of 18-36 months are temporary anchors. This period may vary according to the needs of the project. The estimated service period for permanent anchors is 75-100 years. The factor here is of course how well the structural and systemic integrity of the anchors is protected from internal and external factors. One of four different anchor types is used according to the required stress magnitude and soil environment (Figure 3.).

The applied anchor systems must be safe against various failure scenarios and protected from environmental factors during their service life. After the application, measurements and observations should continue at the construction site. Directions for their maintenance and follow-up are specified in the relevant sections of the regulations.

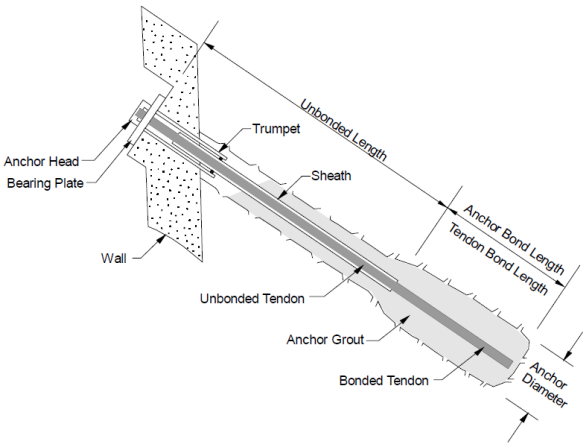

Figure 2. Components of a ground anchor [1]

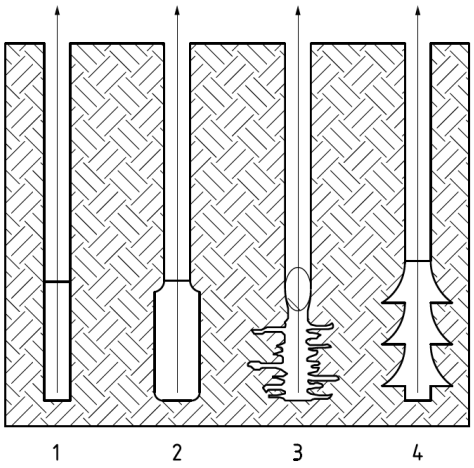

Figure 3. Types of anchorages [2]

Results

While the safety factor for ropes is 1.5 according to the BS 8081:2015 standard, the design load should not exceed 60% of the maximum capacity and the test load should not exceed 80% of the maximum capacity according to the FHWA. According to BS 8081, the minimum free length is 2m for rod elements and 5m for ropes, while these values are 3m and 4.5m, respectively, according to FHWA.

It is stated that the extension of the service life of the anchors will be through maintenance and monitoring. Hazardous situations where these systems require protection against corrosion should be avoided.

After the application, measurements and observations should continue at the construction site.

Discussion

As a result of the studies, it was concluded that the FHWA-IF-99-015 regulation has the widest scope among the examined regulations. While BS 8081:2015 focuses on the issues to be considered during the selection, application, and service life of the elements, FHWA-IF-99-015 also includes detailed calculation steps for different loading and soil types, and the boundary conditions are determined in a stricter framework. In BS 8081:2015, boundary conditions are specified in a softer framework, depending on the designer and the tests to be applied in the field.

Conclusion

When the relevant regulations are examined, it is seen that they are in different languages. To eliminate the disadvantages of this situation, designers, implementers, and supervisors should be informed in their mother tongue.

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