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Behaviour Analysis of D-Wall for RCC Under-Ground Box Structure with Varying Depths

Dr. Rambha Thakur[1], Gaurav Verma[2]

[1]Assistant Professor, Department of Civil Engineering, Rattan Institute of Technology and Management, Haryana, India
[2]Research Scholar, Department of Civil Engineering, Rattan Institute of Technology and Management, Haryana, India

ABSTRACT

Underground structures have been used for several purposes for thousands of years. In present world's population increasing in the urban areas. So, the urban centers will have to adapt, the use of earth below ground level, due to the constraints for surface construction, also connected to environmental issues. With this optimal growth, the population of the cities will have better mobility, quality of life, and economic and social sustainability. In a first phase, this document will present an approach to the work done related to underground structures. Afterwards, we will present some considerations on the numerical calculations and behavioral analysis of D-wall with varying depth. In this study, the options implemented made it possible to successfully execute the works. For the industry, this work is important because it describes a successful management of the aspects under analysis. Diaphragm walls help with retaining excavations designed to take a high structural load.. Diaphragm walls form a rectangular segment framed beneath the soil. The walls are framed in such a way that each panel is interlocked to ensure the stability of the structure and water-holding capacity. Convenient top-down method construction: D-walls can combine with top-down methods of construction to control the deformation of ground buildings and underground structures. A d-wall is significantly quicker and more economical to build.

INTRODUCTION

Underground box structure metro stations cover design of all elements of station like Diaphragm Wall, slab, column, pile etc. The purpose of this document is to produce a unique document of the main procedures and calculations that will be employed for the design and analysis and comparison in the forces generated in the D-wall for different depths at different locations. D-wall using top-down construction methodology is applicable in this type of predominantly clayey and silts soil. Very well suited for hydraulic grab. Suitable for high water level. Requirement of dewatering inside the excavation width is less frequent as the junctions are almost watertight. Any leak to be properly sealed during construction. D-walls can be installed in close proximity to the existing structures. Less settlement of adjacent structure due to higher stiffness. Space is required at the surface for the installation of the separation plant for the production & recycling of bentonite/polymer, for storage of reinforcing cages. The process of constructing the wall is relatively quiet and has little vibration. Verticality can be controlled easily. Wall is strong enough to support the temporary traffic decking. Even traffic may be allowed over fill on roof slab. Requirement of scaffolding and shuttering is negligible, and construction is faster. Cost effective among the various options. The document gives the basis for calculations including the applicable codes and standards, the material properties, the analysis method, the Loadings and Load Combinations to be considered. The D-wall of underground RCC box structure metro station needs to be analysis considering service and construction stages, simulated both in geotechnical as well as structural analysis software. Comparing the output from both the software, critical values have been considered for design.

LITERATURE REVIEW

Recent publications on RCC have focused on several key areas, including mix design, properties, production methods, and applications. Several studies have investigated the effect of different types and amounts of chemical admixtures on the workability and mechanical properties of RC. For example, the use of silica fume and fly ash as partial replacements for cement in RCC has been investigated by researchers such as [13]. These studies have found that the use of these materials can improve the workability, strength, and durability of SCC, while also reducing its environmental impact. Other studies have focused on the development of new production methods for SCC, such as the use of waste materials and alternative mixing techniques. For example, the use of recycled aggregates in SCC production has been investigated by researchers such as [13]. These studies have found that the use of recycled aggregates can improve the sustainability of SCC production, while also maintaining its mechanical properties. In addition to investigating the properties and production methods of SCC, recent publications have also explored the potential applications of SCC in various construction projects. For example, the use of SCC in precast concrete elements has been investigated by researchers such as Bahari et al. (2020) and Wu et al. (2021). These studies have found that SCC can improve the quality and efficiency of precast concrete production, while also reducing the need for external compaction.

EXPERIMENTAL WORK

The station box is constructed by Top-Down Methodology. As a result, at different stages of construction as well as at the final service stage, diaphragm wall will develop different bending moments and stresses. The envelope moment of both the stages are considered for the design of diaphragm wall.

Loads Considered

During the service stage analysis, the station box structure has been checked for combination of all actions (Loads) as mentioned in the Euro code 2. Various loads considered during service stage are as follows: -

Dead Load - Self weight of the structure.

Superimposed Dead Load - Loads of permanent nature like - finishes, partitions, ceilings, services, etc.

Live Load - Variable Loads acting on the structure which are non-permanent in nature. Soil Load - Earth Pressure on D-Wall and Soil Backfill on top of roof slab.

Train Live Load

Surcharge - Both Lateral as well as vertical for Traffic and surrounding buildings Water Pressure

Estimation of Raking Force by STAAD

Next step of Seismic design of underground structures is the establishment of raking force. Raking force is the load required to generate the deflection estimated above. Raking force is to be applied in maximum design forces is adopted following manner.

STAAD Geometry of the Station

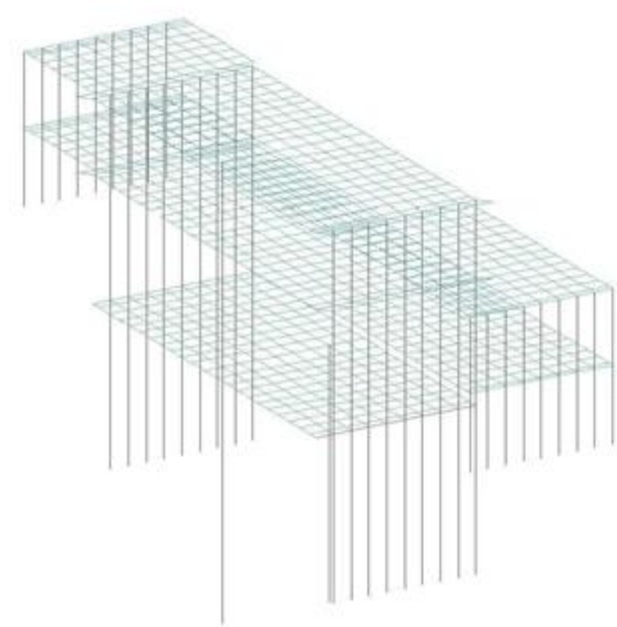

Figure 1 Geometry of The Station

ANALYSIS FOR D-WALL (LARGE HEIGHT)

ULS Normal Case

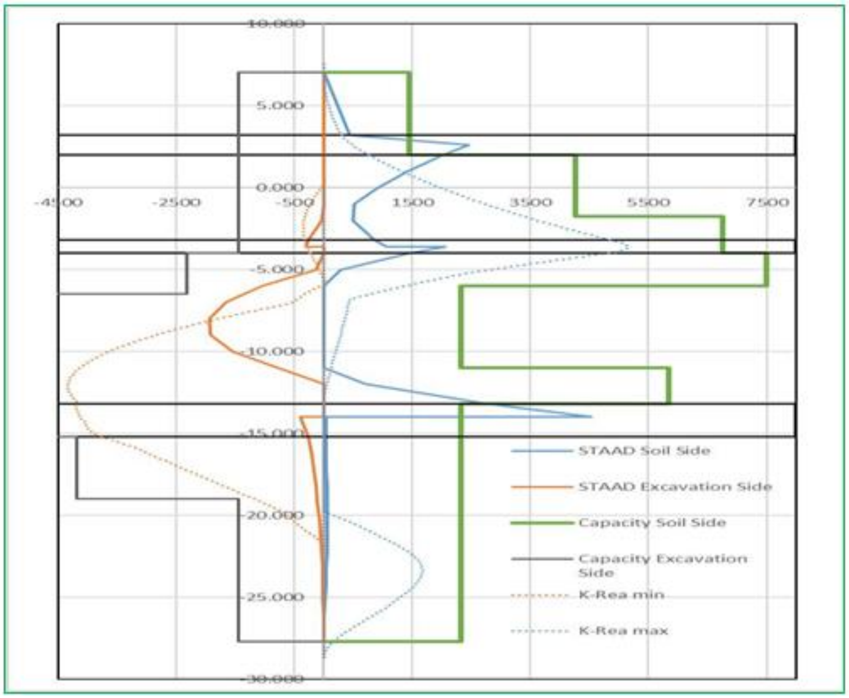

Figure 2 Wall bending moment envelop & section capacity for ULS normal

CONCLUSION

According to the width of the RCC underground box structure, the behaviour of the D-wall changes. For large span width of the box structure, the D-wall requires more stiffness as compared to the small span width cross section, for which the thickness of D-wall required more. For main underground box structure metro station, excavation is done for large depth as shown in above figures i.e. 25m, while for entry-exit part D-wall is of less height i.e. 15m. As discussed above in chapter four large heights D-wall retains large depth of soil, while small height D-wall retains small depth of soil. However, this document analyzed that as the height or depth of D-wall increases, the depth of the retaining earth increases with the increment of excavated side depth or the vacant RCC box structure, the thickness of D-wall will increase.

In main station part the depth of the vacant box structure is required more i.e. 15m, while for the entry-exit box the depth is 6m. Therefore, the bending moment and shear force are quite high in first type of D-wall as compared to the later one. Simultaneously, the reinforcement is required in the same ratio as of the forces. As a conclusion, the D-wall thickness increases with the increasing depth of soil retaining, increasing cross section span of the box structure, and increasing depth of D-wall.

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