The Foundation System of Berjaya Times Square

(Formerly known as Berjaya Star City)

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1.0 INTRODUCTION

Berjaya Times Square (formerly known as Berjaya Star City) currently being furnished is spread over an area of 12 acres in Kuala Lumpur's premier shopping and tourist belt along Jalan Imbi. The 6,000,000 square foot (about 557400 square meters) development is poised to be one of the largest shopping, leisure and entertainment centres in Malaysia. Figure 1 shows the layout of the site.

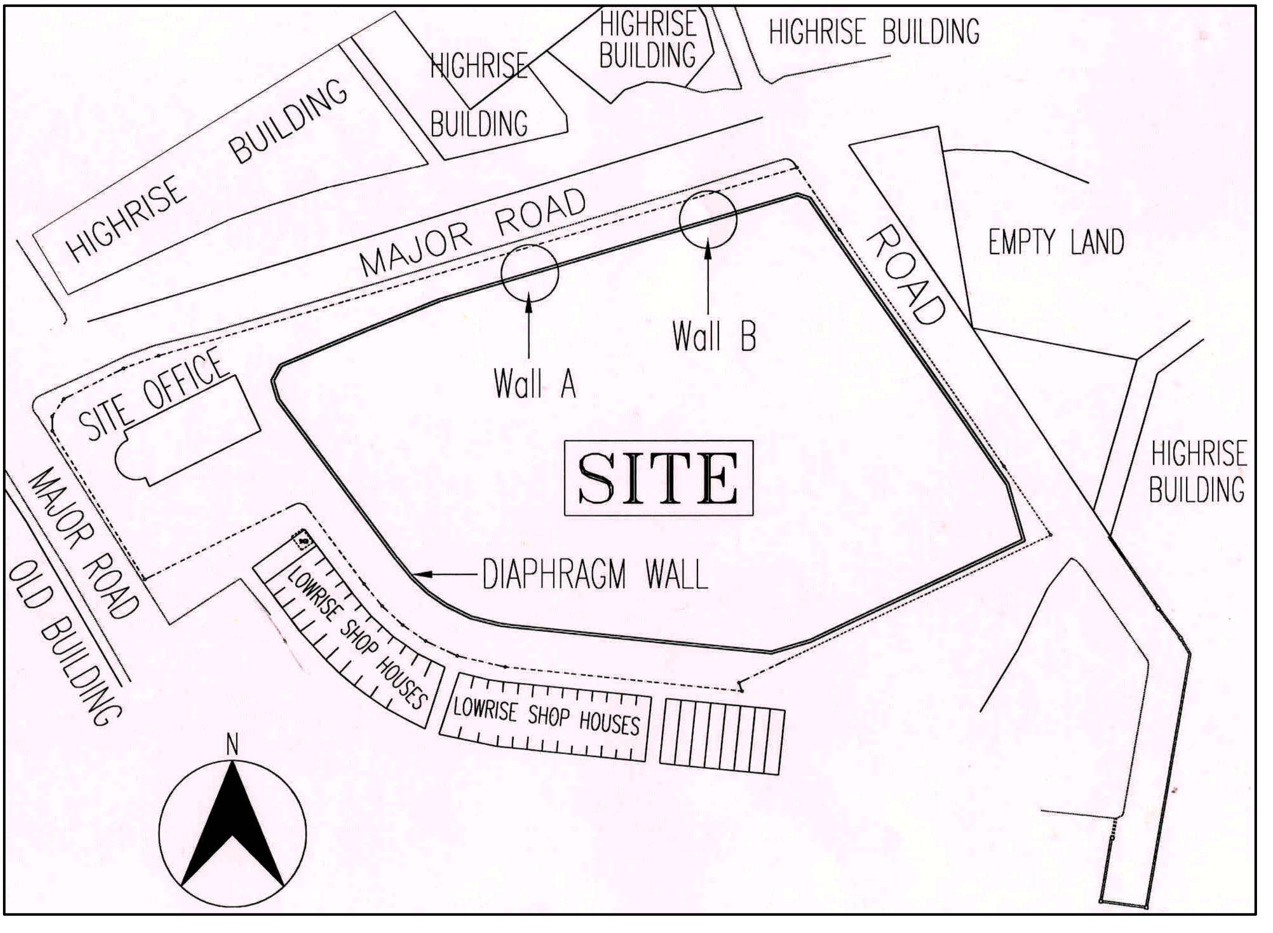

Figure 1 : Layout of the Site.

2.0 GENERAL GEOLOGY

General geology map of Selangor, Malaysia indicates that the site is located in the boundary between the Kenny Hill Formation and Kuala Lumpur Limestone. The subsurface investigations carried out at the site confirmed that the site is on residual soils derived from the Kenny Hill Formation overlying a highly variable karst marble surface, known locally as the Kuala Lumpur Limestone (marble).

The Kenny Hill Formation consists of Carboniferous to Triassic meta-sediment interbedded between meta-arenite and meta-argillite with some quartzite and phyllite. Due to intense weathering process of tropical climate, the meta-sediment has already been transformed into residual and completely weathered soils (Grades V and VI). The Kuala Lumpur Limestone (marble) is of middle to late Silurian Age. This sedimentary limestone sequence was folded and metamorphosed during the Devonian Age. In general, the limestone bedrock is associated with subsurface karstic features such as pinnacles, solution channels and cavities.

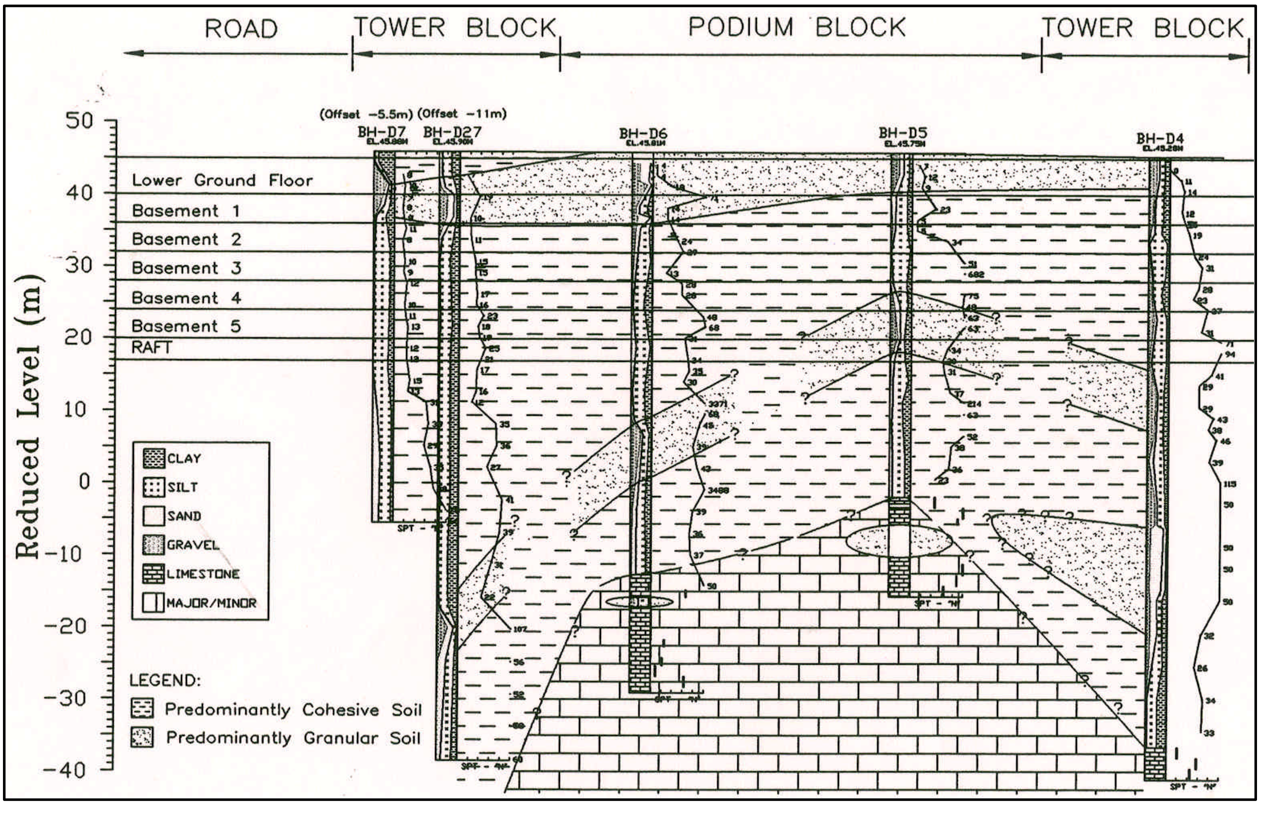

Figure 2 : Typical Subsoil Cross Section.

3.0 SUBSOIL CONDITIONS

The subsurface investigations carried out comprises of rotary wash boring boreholes along the perimeter of the diaphragm wall and inside of the site. Field testing like Standard Penetration Tests (SPT) and pressuremeter tests were also carried out in the boreholes. Standpipe piezometers were installed in the boreholes to measure changes of groundwater level with time for design. The groundwater level measured was generally located at about R.L.+36.0m before excavation. In addition, the disturbed and undisturbed soil samples collected from the boreholes were also tested in laboratory to acquire the necessary soil parameters.

The typical subsoils profile at the site, as shown in Figure 2, indicates that the Kenny Hill residual soils mainly consist of stiff to hard clayey SILT, and silty CLAY with sand or gravel. In between these materials are layers of medium dense to very dense clayey and silty SAND and GRAVEL.

4.0 BASEMENT EXCAVATION

The development consists of a 6-level basement, a 15-storey podium block and two 47-storey towers blocks. The depth of basement excavation was generally 24.5m to 26m and reaching a maximum of 28.5m at the two tower locations. Anchored diaphragm walls of 1.2m thickness with temporary ground anchors of 5 to 7 levels were selected for supporting the surrounding ground. The total plan length of the diaphragm wall is 735m and is generally 42m to 44m deep.

The basement is surrounded by roads and buildings that are to remain operational during the construction of the project. Figure 1 shows the site layout and the surrounding buildings and roads. In view of the close proximity of the adjacent buildings and roads to the site, the control of ground movement formed on the important aspects of the design and construction of the diaphragm walls.

Although the subsoil profile presented in Figure 2 shows variable succession of strata and for analysis purposes, the subsoils were divided into two major components, namely predominantly Granular materials and predominantly Cohesive materials for the design and analysis of the diaphragm walls with different ground anchor configurations.

The wall has been initially designed using a quasi-finite element program (Frew) which allows the interaction between the wall and the soil to be modelled. In the program the soil is modelled as elastic materials on both sides of the wall, utilising pre-stored soil stiffness matrices calculated.

In order to monitor the performance of the wall and validate design assumptions, instruments are installed in the wall and surrounding the site to monitor movements, changes in stresses/force and ground water level. A total of 11 inclinometers access tubes were installed in selected panels and the tubes were extended at least 1m below the toes of the diaphragm wall and assumed to be fixed at the toes of the tubes for monitoring purposes. Other than monitoring the wall movements, the following instruments were also used at this site for specific purposes as detailed below :

- i) Settlement Markers – to measure settlement of retained ground and also on the raft to measure the movement during construction.
- ii) Piezometers – to measure the changes of water pressure in the ground.
- iii) Load Cells – to measure load changes at the temporary ground anchors.
- iv) Deep Extensometers – to measure the heaving of the ground due to the deep excavation.

Based on the instrumentation monitoring results, the walls was back-analysed and validated during construction and after construction. Figure 3 shows the plane strain condition FEM model of the diaphragm wall in initial stage utilising 6-node elements under 2-D plane strain condition. For details, the following papers can be referred :

- (a) GUE, S.S. & TAN, Y.C. (1998), Performance of Anchored Diaphragm Walls for Deep Basement in Kuala Lumpur, Malaysia, *Proceedings of the 13th Southeast Asian Geotechnical Conferences*, Taipei, pp. 511-517.
- (b) TAN, Y.C. (1997), Deformation of Anchored Diaphragm Walls for Deep Basement at Berjaya Star City, Kuala Lumpur, Proceedings

of the *Third Asian Young Geotechnical Engineers Conference 1997*, Singapore, pp.121-130.

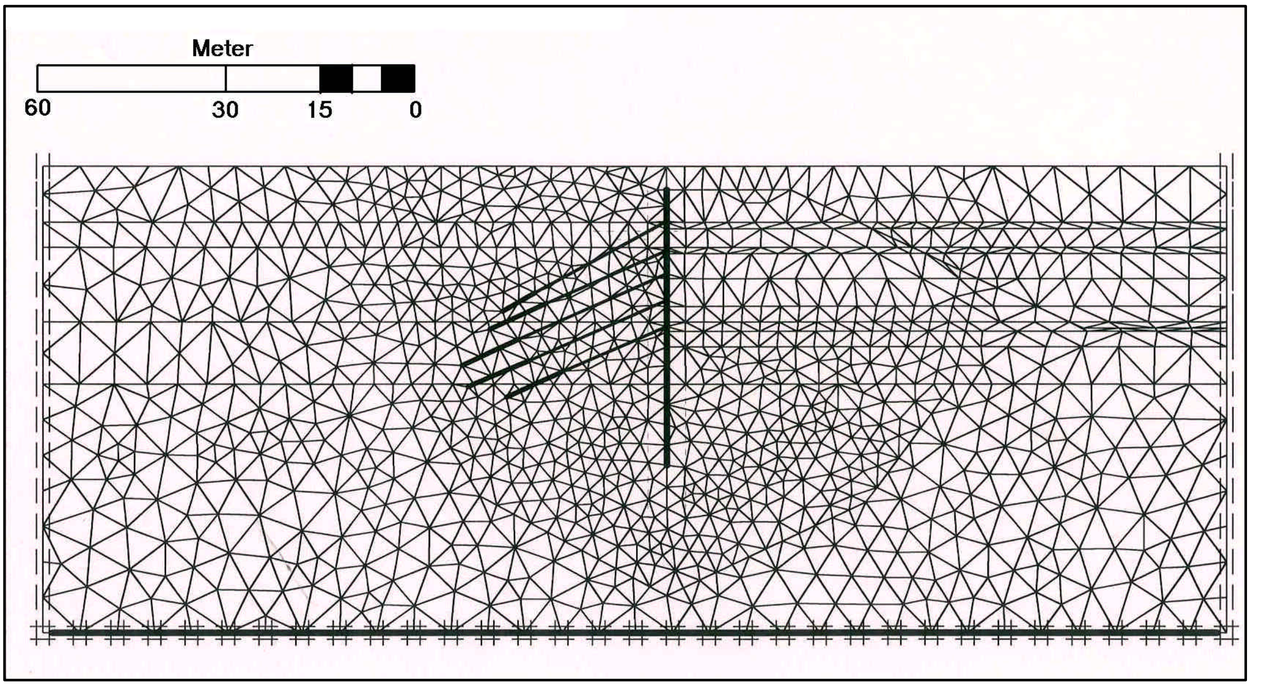

Figure 3 : Finite Element Modelling of Excavation.

5.0 FOUNDATION SYSTEM

The 15-storey podium block and two 47-storey towers blocks are linked by the 6-level basement. Two different types of foundation system are adopted for the two different structures. For the 15-storey podium block, raft foundation is adopted. At certain locations where the weight of the building is not enough to resist uplift due to water pressure, tension piles are introduced. Bored piles raft is used to support the two 47-storeys towers. Figure 4 shows the schematic cross-section of the two proposed foundation systems. The layout of the foundation system namely bored piles and tension micropiles is shown in Figure 5.

5.1 Raft Foundation

Raft foundation system with raft thickness of 2.3m is used as the foundation system for the 15-storey podium block and the 6-level basement. This is feasible because the compensated 24m deep basement excavation reduces significantly the overburden pressure acting on the subsoil beneath the lowest basements level, therefore the subsoil is capable of supporting the loading from the structures. Due to the net uplift pressure from hydrostatic pressures acting on the raft particularly at the voids area of the podium, tension micropiles are introduced to anchor it at locations where the dead load from the structures is insufficient to counteract the uplift.

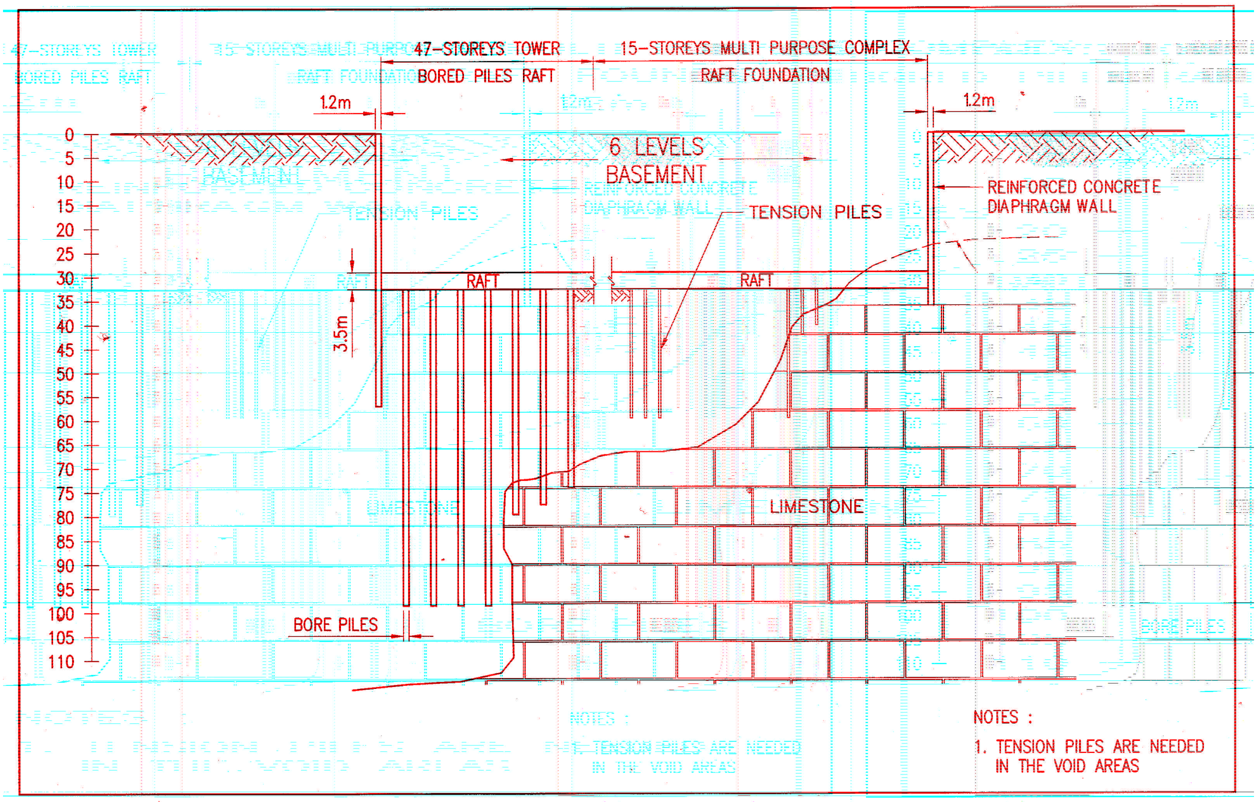

Figure 4 : Schematic Cross-Section of the Foundation System

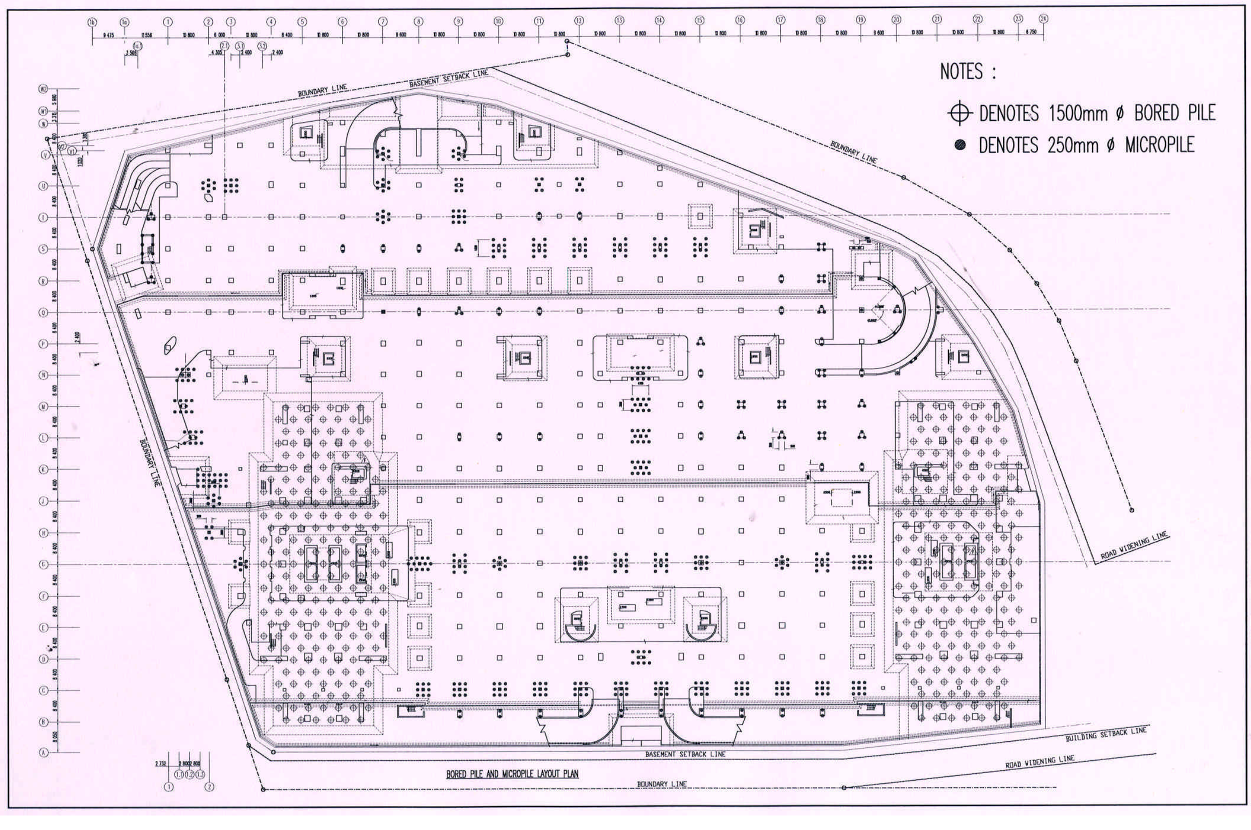

Figure 5 : Foundation Layout.

5.2 Bored Piles Raft

For the two 47-storey towers blocks, bored piles raft foundation system is employed. The size of the bored piles is 1500mm in diameters providing geotechnical capacity of more than 11000kN. The thickness of the raft required to transfer the high columns load to the bored piles is 3.5m.

Generally, the bored piles are designed to socket into the limestone bedrock if the limestone bedrock is shallow. If the limestone bedrock is very deep, then bored piles on skin friction are being used. The depth of the skin friction pile is 58m.

6.0 CONCLUSION

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