The Breezeway @Desa Parkcity

Alternative Design with Caisson Pile and Deep Transfer Beam

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Introduction

The Breezeway

This is a mixed development which consists of 3 (48 units) and 3-1/2 (28 units) storey park home and a 31 storey high rise condominium of 139 units including 5 levels podium and 1 level of car park. Two different type of foundation system are introduced by project consultant: the high rise tower is founded on bored pile system and the low rise is founded on raft foundation treated with dynamic compaction. Our package of work included only high rise foundation and the low rise foundation package was carried out earlier by other specialist contractor. The total construction duration for the high rise foundation is 8 months with partial handing over of section 1 in 6 months from the date of site possession.

Construction Site

Caisson Rock Socket

Existing Soil Profile

Looking back the history of Desa Park, it was an ex-quarry site with the leftover of rock fragments and traces of rock blasting. The developer has successfully turned this ex-quarry site into the high end luxury residential area. However, the leftover rock debris and the ex-mining pond have posted great challenge to Geotechnical Engineer who is searching for a system which is economical in term of cost but is equivalent sound too in term of engineering. Append herewith one of the typical borehole result from the 20 number of SI borehole done at site:

BH - 15

Depth (m)	Rec/RQD/SPT	Legend	
0	0	Gn	Backfill Rock Segment
1.5	50%/15%	Gn	
3	53%/40%	Gn	
4.5	17%/Nil	Gn	
6	20%/Nil	Gn	
7.5	43%/Nil	Gn	
9	37%/Nil	Gn	▽ 10.0m GWL
10.5	Nil/Nil	Gn	
12	25%/20%	Gn	
13.5	29%/20%	Gn	
15	22%/Nil	Gn	
16.5	10%/Nil	Gn	
18	Nil/Nil	Gn	
19.5	13	sC	Silty Sand
21	16	sC	
22.5	9	siS	
24	11	siS	
25.5	24	siS	
27	55	siS	Dense to very dense Silty Sand
28.5	77	siS	
30	103	siS	
31.5	111	siS	
33	97	siS	
34.5	115	siS	
36	107	siS	
36.29	End @ 36.29m		

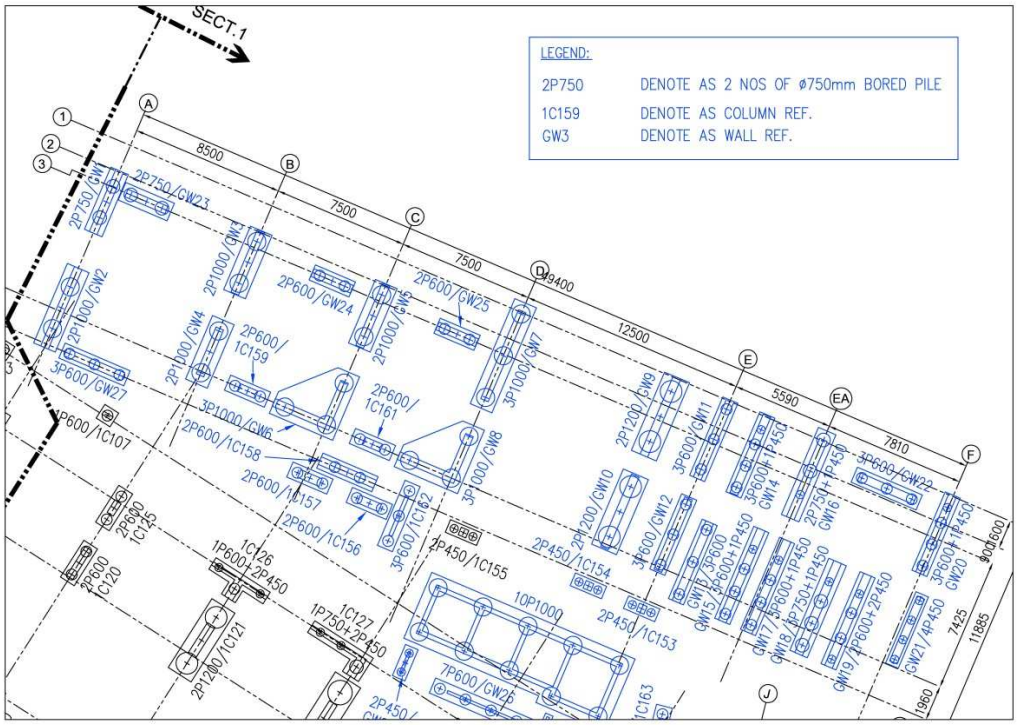
Apparently, the appearance of highly fractured moderately weathered Granite from the ground level up to the depth of 18m is not a bedrock formation. This is the backfilling material from rock fragments mixing with the sandy soil. After the layer of backfilled rock fragments, underlying the original soil material consists of silty sand / sandy silt layer varies form medium dense to very dense/stiff which is completely weathered Granite before reaching to the original bedrock level of Granite formation.

Alternative Design Development

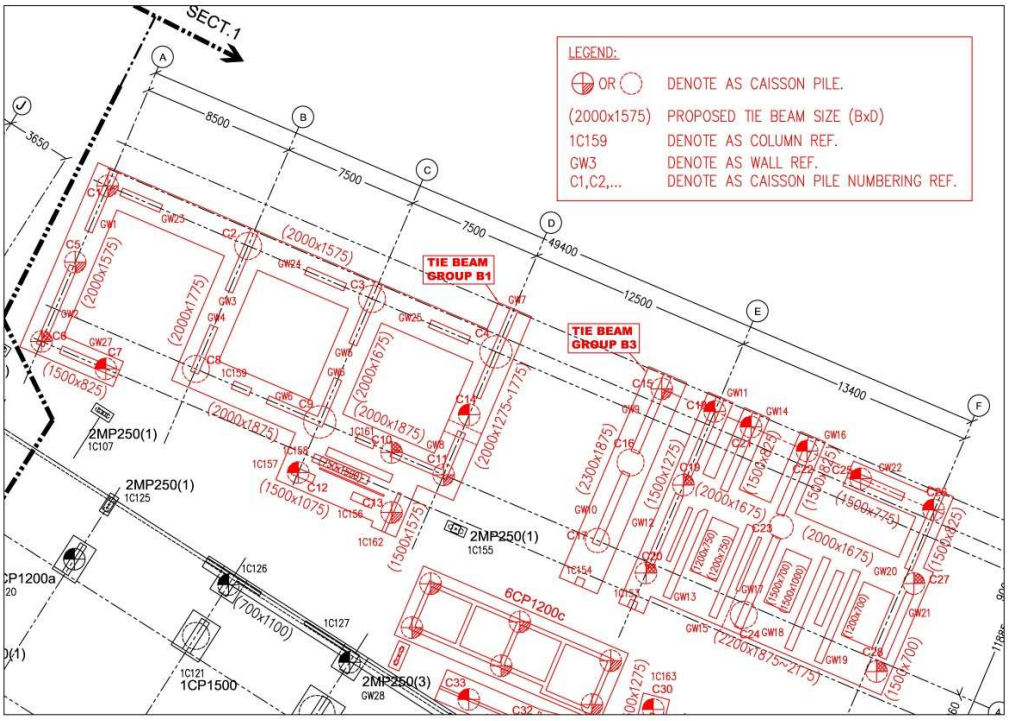
Due to the present of backfilled rock fragments and loose sandy soil with depth from ground level up to maximum of 18m, this layer of material posed a great challenge and uncertainty of successfully forming bored hole with the bored pile system. It is almost impossible to drive temporary casing with the present of the loose backfilled rock fragment. By applying the pre-bored with larger diameter prior to the installation of temporary casing, the stability of bored hole may not able be maintained if the depth of bored hole of beyond 6m. The only suitable method to overcome the above problem of deep layer backfilled rock is either using hand dug caisson to remove the rock filled manually or using micropile with the contiguous casing reaming system.

If the approach is to replace directly original bored pile design with the equivalent caisson pile or micropile, the overall foundation cost will be much higher than the original budgeted cost. Therefore, the holistic approach is by reviewing the overall foundation design to integral with the structural system. In comparing the pile carrying capacity of caisson pile to bored pile, we noticed that the capacity of caisson pile was not fully being utilized due to the limit of smallest size caisson of 1200mm diameter. As such, most of the load bearing wall/shear wall was designed to be supported by deep transfer beam in order to transfer the floor load to the both end with caisson pile support. With the use of deep transfer beam, most of the caisson pile capacity can be fully utilized up to 80% of the allowable structural

capacity. At the same time, the number of caisson pile can be effectively reduced to the required number to support the whole structure. The following shows the part drawing from original bored pile design comparing to the alternative design based on the integration of caisson pile with the structural system:



Original design with bored pile foundation



Alternative design with caisson pile & deep transfer beam

Construction Challenges

The overall construction of 8 months is a very challenging task to achieve, especially with the partial handing over of section 1 in the first 6 month. The success or failure to complete on time for this project was solely replying on caisson pile excavation which was felled under the critical path for the entire project. We managed to overcome the labour resources by developing almost the full team of labour trying to complete the excavation work in 2 cycles against the original plan of 4 cycles. However, another critical challenge is the present of soft and loose sandy soil in the backfilled layer even present in the original soil below the backfilled layer. The caisson excavation was forced to slow down with the shorter lift of excavation for each day. In addition, dewatering of caisson bored hole prior to the excavation was a daily struggle need to overcome too.

At last, the final cycle of caisson pile was changed to bored pile after clearing through the backfilled rock layer due to the time constraint. Otherwise, the section 2 structural work will be definitely delayed by the caisson pile excavation. The change of the caisson pile to bored pile at the last second is clearly proven that is a right move so that the overall work can be completed within the contract duration.