

Setia City Res@Setia Alam

The Challenges and Solutions on Full Bored Pile Foundation

(by Ms. Supia Kilat, Design Engineer and Mr. Lai Chee Yong, DGM-Operations) (2016 Oct-Dec)

Project Introduction

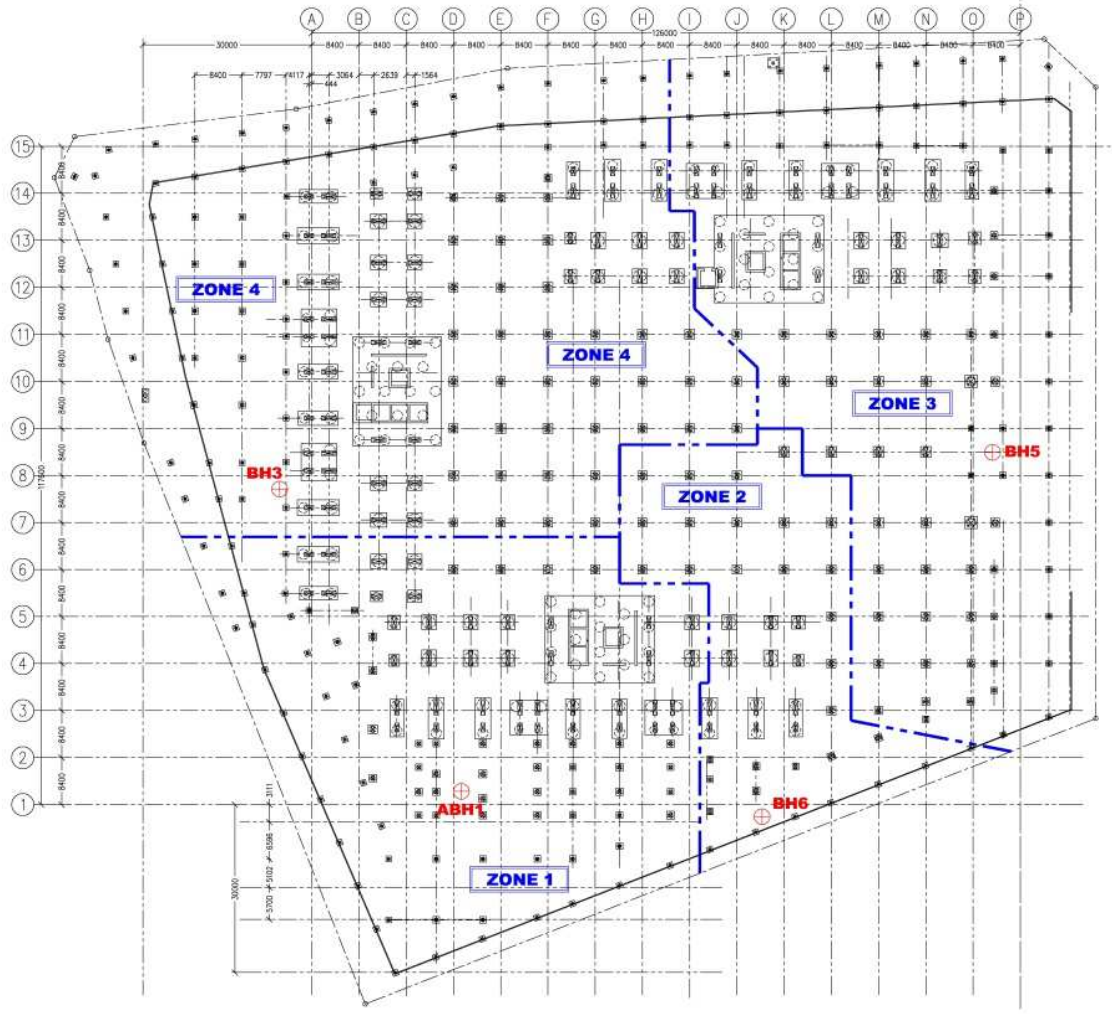
This development project is located at Setia Alam which comprises of 3 blocks high rise condominium with 35 storeys including 5 storeys of podium car park with a few units of retail shops. The foundation is under *Contractor Alternative Design* which consists of 496 number of bored piles with sizes ranging from 600mm to 2200mm diameter. The total construction duration in contract is 9 months which includes piling and pilecap works.



Project Site Photo

Alternative Design Proposal

We proposed a full bored pile foundation system to replace the original combination of bored piles and spun pile system. We introduced 2 types of concrete grade, i.e. G35 and G40 for various sizes of bored pile in order to optimise the pile working load and hence optimise the pile length. Based on the soil investigation data during the tender stage, the piling layout was divided into 4 Zones and all the piles were designed based on soil friction and end bearing.



Alternative Piling Layout

Design Challenges

There is a 12m depth of alluvial deposit in the top soil layer which consists of very loose to loose Silty CLAY with dark grey colour. The contribution of geotechnical capacity of the pile length is almost negligible in this soft soil layer. But the most critical issue that make us worry is the soil stability during deep pilecap excavation work and the difficulties are shared in the next construction challenge page. After this 12m deep of soil, a typical sedimentary rock formation of highly weathered sandstone is encountered. All the rock sample cores are less than 100% recovery and mostly 0% in RQD. Therefore, we decided not to consider as rock socketed pile to avoid argument in rock definition during construction stage.

Geohan Sdn Bhd - Technical Write-up

BH REF RL (m) GWT (m/g)	BH1 10.293 0.50 (Standpipe Piezometer)				BH3 9.670 0.62				BH5 10.676 2.17				BH6 10.983 1.57				LEGEND		
	Depth (m)	STP-N	Colour	Soil	Depth (m)	STP-N	Colour	Soil	Depth (m)	STP-N	Colour	Soil	Depth (m)	STP-N	Colour	Soil		SI	CLAY
10.676	0	0	Light Brown Pale Brown	sSi	0	0	Brownish Reddish Yellow	cSi	0	0	Reddish Brown	cS	0	0	Reddish Yellow Brown	sSi	S	SAND	
9.176	1.5	0	Grey Brown	s/C	0	0	Pinkish Brown Grey	cSi	1.5	23	Greyish Brown	s/S	1.5	15	Yellowish Brown Reddish	cS	Gr	GRAVEL	
7.676	3	0	Grey Brown	s/C	1.5	5	Dark Grey	cSi	3	16	Brownish Grey	s/S	3	1	Purplish Dark Grey	s/C	GN	GRANITE	
6.176	4.5	0	Grey Brown	s/C	3	1	Dark Grey	cSi	4.5	13	Reddish Yellow Brown	s/S	4.5	0	Dark Grey	s/C	LM	LIMESTONE	
4.676	6	1	Grey Brown	s/C	4.5	0	Dark Grey	cSi	6	0	Dark Grey	s/C	6	0	Dark Grey	s/C	SD	SANDSTONE	
3.176	7.5	27	Light Brown Reddish Brown	s/C	6	10	Reddish Grey Brown	cSi	7.5	0	Dark Grey	s/C	7.5	1	Dark Grey	s/C	SI	SILTSTONE	
1.676	9	16	Grey Brown	s/C	7.5	16	Yellowish Brown Reddish	s/S	9	0	Dark Grey	s/C	9	1	Dark Grey	s/C	MD	MUDSTONE	
0.176	10.5	9	Grey Brown	s/C	9	19	Yellowish Brown Reddish	cSi	10.5	0	Dark Grey	s/C	10.5	2	Dark Grey	s/C	Sch	SCHIST	
-1.324	11	9	Light Brown Medium Yellow	sSi	10.5	25	Brownish Orange Reddish	cSi	12	8	Pinkish White Grey	cSi	12	6	Brown Grey	cSi	SH	SHALE	
-2.824	12	9	Light Brown Medium Yellow	cSi	12	20	Yellowish Pink	sSi	13.5	12	Pinkish White Brown	sSi	13.5	8	Yellowish Grey	sSi	Qtz	QUARTZ	
-4.324	13.5	13	Light Brown Medium Yellow	cSi	13.5	23	Purplish Yellow Pink	cSi	15	15	Pinkish White Brown	sSi	15	9	Yellowish Reddish	cSi	WD	WOOD	
-5.824	15	16	Light Brown Medium Yellow	cSi	15	50	Pale Grey Brown Purple	cSi	18.5	23	Orange Pale Grey	sSi	18.5	14	Yellowish Reddish	cSi	cSi	clayey SILT	
-7.324	16.5	18	Light Brown Medium Yellow	cSi	16.5	68	Pale Grey Brown Purple	cSi	18	45	Yellow Pale Grey	sSi	18	19	Greyish Reddish	cSi	cSi	clayey SAND	
-8.824	18	32	Brownish Yellow Medium Reddish	s/C	18	34	Purplish Brown	cSi	19.5	75	Whitish Pale Grey	s/S	19.5	22	Yellowish Grey	cSi	s/S	silty SAND	
-10.324	19.5	39	Brownish Yellow Medium Reddish	s/C	19.5	29	Pale Grey Reddish Brown	cSi	21	200	Greyish Yellow	sSi	21	25	Reddish Brown	cSi	s/Gr	silty GRAVEL	
-11.824	21	41	Brownish Yellow Medium Reddish	s/C	21	51	Pale Grey Yellow Brown	cSi	22.5	250	Greyish Yellow	sSi	22.5	33	Yellowish Brown Reddish	sSi	cSi	silty CLAY	
-13.324	22.5	47	Brownish Yellow Medium Reddish	s/C	22.5	79	Yellowish Brown	cSi	24	231	Orangeish Brown	s/S	24	28	Pale Grey Brown Yellow	cSi	s/C	sandy CLAY	
-14.824	24	50	Pale Grey Light Purple	cS	24	83	Yellowish Brown Purple Grey	cSi	25.5	250	Orangeish Brown	s/S	25.5	44	Pale Grey Brown Yellow	cSi	s/Gr	sandy GRAVEL	
-16.324	25.5	58	Pale Grey Light Purple	cS	25.5	100	Yellowish Brown Purple Grey	cSi	27	214	Pinkish Yellow	sSi	27	103	Yellowish Purple Grey	cSi	sSi	sandy SILT	
-17.824	27	24	Pale Grey Light Purple	cS	27	75	Pale Grey Purple Brown	sSi	28.5	231	Brownish Yellow	sSi	28.5	158	Pale Grey Purple	cSi	p/S	gravelly SAND	
-19.324	28.5	15	Pale Grey Light Purple	cS	28.5	176	Pale Grey Purple Brown	sSi	30	250	Brownish Yellow	sSi	30	167	Pale Grey Purple	cSi	p/Si	gravelly SILT	
-20.824	30	42	Pale Grey Light Purple	cS	30	200	Brownish Pale Grey	sSi	31.5	>300	No Recovery - Hammer Rebound (Suspected Weathered Rock)		31.5	176	Yellowish Purple	cSi	p/C	gravelly CLAY	
-22.324	31.5	200	Light Brown	s/S	31.5	250	Brownish Pale Grey	sSi	31.8	60%/0%	Yellowish Brown Grey SD (Boulder)		33	214	Reddish Brown	sSi	p	pavement	
-23.824	33	125	Light Brown (Decomposed SD)	s/S	33	214	Whitish Pale Grey	sSi	32.8	214	Greyish Yellow Brown	sSi	34.5	273	Pale Grey White Yellow	cSi			
-25.324	34.5	130	Light Brown	s/S	34.5	214	Pale Grey Brown	sSi	33	214	Greyish Yellow Brown	sSi	36	250	Pale Grey Brown	cSi		SPT Values - Blows / 30cm	
-26.824	36	143	Pale Brown	s/S	36	250	Brownish Grey	sSi	34.5	200	Greyish Yellow Brown	sSi	37.5	231	Pale Grey Brown	cSi			
-28.324	37.5	150	Pale Brown (Decomposed SD)	s/S	37.5	300	Brownish Grey	sSi	36	250	Greyish Yellow	s/S	38	93%/0%	Pale Grey Brown	SD		0-10	
-29.824	38.5	80%/0%	Pale Grey Light Brown	SD	39	93%/0%	Brownish Grey	SD	37.5	250	Greyish Yellow	s/S	39.5	87%/0%	Greyish Brown	SD		11-30	
-31.324	40	80%/0%	Pale Grey Light Brown	SD	40.5	98%/0%	Brownish Grey	SD	39	250	Yellowish Brown	s/S	41	100%/0%	Greyish Brown	SD		31-49	
-32.824	41.5	73%/0%	Pale Grey Light Brown	SD	42	83%/8%	Pale Grey Brown	SD	40.5	200	Pale Grey Yellow Brown	cSi	42.5	87%/7%	Greyish Brown	SD		50& ABOVE	
-34.324	43	87%/0%	Pale Grey Light Brown	SD	43.5	100%/8%	Pale Grey Brown	SD	42	214	Pale Grey Brown	cSi	44	98%/0%	Greyish Brown	SD		ROCK	
-35.824	44.5	87%/0%	Pale Grey Light Brown	SD	45	93%/15%	Pale Grey Brown	SD	43.5	231	Greyish Brown	cSi	45.5	80%/8%	Greyish Brown	SD			
-37.324	46.5	93%/0%	Pale Grey Brown	SD	46.5	93%/0%	Pale Grey Brown	SD	45	250	Greyish Brown	cSi	47	83%/10% (23.1)	Greyish Brown	SD		For SOIL - SPT Values	
-38.824	48	95%/10%	Pale Grey Brown	SD	46	80%/8%	Brownish Grey	SD	46	80%/8%	Brownish Grey	SD	48.5	87%/0%	Brownish Pale Grey	SD		For ROCK-REC (%RQD)(%)	
-40.324	49.5	100%/12%	Pale Grey Brown	SD	47.5	100%/12%	Pale Grey Brown	SD	47.5	90%/12% (27.7)	Pale Grey Brown	SD	50	93%/0%	Brownish Pale Grey	SD		(23.1)-UCT Test (N/mm2)	
-41.824	50	100%/15%	Pale Grey Brown	SD	49	100%/15%	Pale Grey Brown	SD	50	100%/15%	Pale Grey Brown	SD	51.5	90%/0%	Brownish Pale Grey	SD			
-43.324	50	END @ 50.00m			50	END @ 50.00m			50	END @ 50.00m			53	87%/0%	Brownish Pale Grey	SD			
-44.824	50	END @ 50.00m			50	END @ 50.00m			50	END @ 50.00m			54.5	90%/0%	Brownish Pale Grey	SD			
-46.324	56	87%/18% (16)	Brownish Pale Grey	SD	56	87%/18% (16)	Brownish Pale Grey	SD	56	87%/18% (16)	Brownish Pale Grey	SD	57.5	80%/15% (25.4)	Brownish Pale Grey	SD			
-47.824	57.5	80%/15% (25.4)	Brownish Pale Grey	SD	57.5	80%/15% (25.4)	Brownish Pale Grey	SD	57.5	80%/15% (25.4)	Brownish Pale Grey	SD	59	100%/16% (15.5)	Brownish Pale Grey	SD			
-49.324	59	100%/16% (15.5)	Brownish Pale Grey	SD	59	100%/16% (15.5)	Brownish Pale Grey	SD	59	100%/16% (15.5)	Brownish Pale Grey	SD	60	END @ 60.00m					

SI Result

BH REF RL (m)	ABH1 10.283				BH3 9.670			
	0.50 (Standpipe Piezometer)				0.62			
GWT (mbgl)	Depth (m)	STP-N	Colour	Soil	Depth (m)	STP-N	Colour	Soil
10.676	0	0	Light Brown Pale Brown	sSi				
9.176	1.5	0	Grey Brown	siC	0	0	Brownish Reddish Yellow	cSi
7.676	3	0	Grey Brown	siC	1.5	5	Pinkish Brown Grey	cSi
6.176	4.5	0	Grey Brown	siC	3	1	Dark Grey	cSi
4.676	6	1	Grey Brown	siC	4.5	0	Dark Grey	cSi
3.176	7.5	27	Light Brown Reddish Brown	siC	6	10	Reddish Grey Brown	cSi
1.676	9	16	Grey Brown	siC	7.5	16	Yellowish Brown Reddish	cSi
0.176	10.5	9	Grey Brown	siC	9	19	Yellowish Brown Reddish	cSi
-1.324	11	9	Dark Brown	sSi	10.5	25	Brownish Orange Reddish	cSi
-2.824	12	9	Light Brown Medium Yellow	cSi	12	20	Yellowish Pink	sSi
-4.324	13.5	13	Light Brown Medium Yellow	cSi	13.5	23	Purplish Yellow Pink	cSi
-5.824	15	16	Light Brown Medium Yellow	csSi	15	50	Pale Grey Brown Purple	cSi
-7.324	16.5	18	Light Brown Medium Yellow	cSi	16.5	68	Pale Grey Brown Purple	cSi
-8.824	18	32	Brownish Yellow Medium Reddish	siC	18	34	Purplish Brown	cSi
-10.324	19.5	39	Brownish Yellow Medium Reddish	siC	19.5	29	Pale Grey Reddish Brown	cSi
-11.824	21	41	Brownish Yellow Medium Reddish	siC	21	51	Pale Grey Yellow Brown	cSi
-13.324	22.5	47	Brownish Yellow Medium Reddish	siC	22.5	79	Yellowish Brown	cSi
-14.824	24	50	Pale Grey Light Purple	cS	24	83	Yellowish Brown Purple Grey	cSi
-16.324	25.5	58	Pale Grey Light Purple	cS	25.5	100	Yellowish Brown Purple Grey	cSi
-17.824	27	24	Pale Grey Light Purple	cS	27	75	Pale Grey Purple Brown	sSi
-19.324	28.5	15	Pale Grey Light Purple	cS	28.5	176	Pale Grey Purple Brown	sSi
-20.824	30	42	Pale Grey Light Purple	cS	30	200	Brownish Pale Grey	sSi
-22.324	31.5	200	Light Brown	siS	31.5	250	Brownish Pale Grey	sSi
-23.824	33	125	Light Brown	(Decomposed SD)	33	214	Whitish Pale Grey	sSi
-25.324	34.5	130	Light Brown	siS	34.5	214	Pale Grey Brown	sSi
-26.824	36	143	Pale Brown	siS	36	250	Brownish Grey	sSi
-28.324	37.5	150	Pale Brown	(Decomposed SD)	37.5	300	Brownish Grey	sSi
-29.824	38.5	80%/0%	Pale Grey Light Brown	SD	39	93%/0%	Brownish Grey	SD
-31.324	40	80%/0%	Pale Grey Light Brown	SD	40.5	98%/0%	Brownish Grey	SD
-32.824	41.5	73%/0%	Pale Grey Light Brown	SD	42	83%/8%	Pale Grey Brown	SD
-34.324	43	87%/0%	Pale Grey Light Brown	SD	43.5	100%/8%	Pale Grey Brown	SD
-35.824	44.5	END @ 44.50m			45	93%/15%	Pale Grey Brown	SD
-37.324					46.5	93%/0%	Pale Grey Brown	SD
-38.824					48	95%/10%	Pale Grey Brown	SD
-40.324					49.5	100%/12%	Pale Grey Brown	SD
-41.824					50	END @ 50.00m		

SI Result : Blow up

BH5 10.676				BH6 10.083				LEGEND	
2.17				1.57				C	CLAY
Depth (m)	STP-N	Colour	Soil	Depth (m)	STP-N	Colour	Soil	SI	SILTY
0	0	Reddish Brown	cS	0	0	Reddish Yellow Brown	sSi	S	SAND
1.5	23	Greyish Brown	sSi	1.5	15	Yellowish Brown Reddish	cS	Gr	GRAVEL
3	16	Brownish Grey	siS	3	1	Purplish Dark Grey	siC	GN	GRANITE
4.5	13	Reddish Yellow Brown	sSi	4.5	0	Dark Grey	siC	LM	LIMESTONE
6	0	Dark Grey	siC	6	0	Dark Grey	siC	SD	SANDSTONE
7.5	0	Dark Grey	siC	7.5	1	Dark Grey	siC	SI	SILTSTONE
9	0	Dark Grey	siC	9	1	Dark Grey	siC	MD	MUDSTONE
10.5	0	Dark Grey	siC	10.5	2	Dark Grey	siC	Sch	SCHIST
12	8	Pinkish White Grey	cSi	12	6	Brown Grey	cSi	SH	SHALE
13.5	12	Pinkish White Brown	sSi	13.5	8	Yellowish Grey	siS	Qtz	QUARTZ
15	15	Pinkish White Brown	sSi	15	9	Yellowish Reddish	cSi	WD	WOOD
16.5	23	Orange Pale Grey	sSi	16.5	14	Yellowish Reddish	cSi	cSi	clayey SILT
18	45	Yellow Pale Grey	sSi	18	19	Greyish Reddish	cSi	cS	clayey SAND
19.5	75	Whitish Pale Grey	siS	19.5	22	Yellowish Grey	cSi	siS	silty SAND
21	200	Greyish Yellow	sSi	21	25	Reddish Brown	cSi	siGr	silty GRAVEL
22.5	250	Greyish Yellow	sSi	22.5	33	Yellowish Brown Reddish	sSi	siC	silty CLAY
24	231	Orangish Brown	siS	24	28	Pale Grey Brown Yellow	cSi	sC	sandy CLAY
25.5	250	Orangish Brown	siS	25.5	44	Pale Grey Brown Yellow	cSi	sGr	sandy GRAVEL
27	214	Pinkish Yellow	sSi	27	103	Yellowish Purple Grey	cSi	sSi	sandy SILT
28.5	231	Brownish Yellow	sSi	28.5	158	Pale Grey Purple	cSi	grS	gravelly SAND
30	250	Brownish Yellow	sSi	30	167	Pale Grey Purple Yellow	cSi	grSi	gravelly SILT
31.5	>300	No Recovery - Hammer Rebound	(Suspected Weathered Rock)	31.5	176	Yellowish Purple	cSi	grC	gravelly CLAY
31.8	60%/0%	Yellowish Brown Gray	SD (Boulder)	33	214	Reddish Brown	sSi	p	pavement
32.8	214	Greyish Yellow Brown	sSi	34.5	273	Pale Grey White Yellow	cSi		
33	214	Greyish Yellow Brown	sSi	36	250	Pale Grey Brown	cSi		SPT Values -Blows / 30cm
34.5	200	Greyish Yellow Brown	sSi	37.5	231	Pale Grey Brown	cSi		
36	250	Greyish Yellow	siS	38	93%/0%	Pale Grey Brown	SD		0-10
37.5	250	Greyish Yellow	siS	39.5	87%/0%	Greyish Brown	SD		11-30
39	250	Yellowish Brown	sSi	41	100%/0%	Greyish Brown	SD		31-49
40.5	200	Pale Grey Yellow Brown	cSi	42.5	97%/7% (17)	Greyish Brown	SD		50& ABOVE
42	214	Pale Grey Brown	cSi	44	98%/0%	Greyish Brown	SD		ROCK
43.5	231	Greyish Brown	cSi	45.5	80%/8%	Greyish Brown	SD		
45	250	Greyish Brown	cSi	47	83%/10% (23.1)	Greyish Brown	SD		
46	80%/8%	Brownish Grey	SI	48.5	87%/0%	Brownish Pale Grey	SD		For SOIL -SPT Values
47.5	90%/12% (27.7)	Pale Grey Brown	SD	50	93%/0%	Brownish Pale Grey	SD		For ROCK-REC (%RQD)(%)
49	100%/15%	Pale Grey Brown	SD	51.5	90%/0%	Brownish Pale Grey	SD		(23.1)-UCT Test (N/mm2)
50		END @ 50.00m		53	87%/0%	Brownish Pale Grey	SD		
				54.5	90%/0%	Brownish Pale Grey	SD		
				56	87%/18% (16)	Brownish Pale Grey	SD		
				57.5	80%/15% (25.4)	Brownish Pale Grey	SD		
				59	100%/16% (15.5)	Brownish Pale Grey	SD		
				60		END @ 60.00m			

SI Result : Blow up

From the instrumented test pile result, we are able to achieve average ultimate soil skin friction of 3XSPT-N (kpa), average ultimate friction of highly decomposed sandstone of more than 500kPa and ultimate end bearing capacity more than 3800kPa.

The most challenging of this project during design stage is the pile designation with considering pile to pile spacing 2.5d in tower area due to very close 2 adjacent columns position. It was actually can be designed for single pile at a column. But due to the pile spacing requirement, these 'Single-Piles' were spaced out by 2.5d and combined with a pilecap. Therefore, we decided to combine the 2 or 4 columns into a pilecap. All of the pilecaps were designed by using SAFE software and Prokon programme in order to get a more accurate pilecap reinforcement and forces.

Upon completion of the project, there are 1nos of instrumented MLT on BP1200, 1nos of subsequent MLT on BP1800 and 25 nos of PDA testing have been carried out to verify the performance of working piles at various zone. All the test results were shown in compliance to minimum factor of safety of more than 2.0 in geotechnical capacity.

Construction Challenge (By Mr. Lai Chee Yong)

The bored pile construction for this project is quite direct due to the ample space and flat ground. The challenge would be maintaining the flat ground and accessibility of routes for the continuation of subsequent works. As with many projects, time is of essence to the timeline of the project. At peak, 5 boring rigs were deployed to site together with 4 cranes and 6 units of excavators. The entire site looks like a chess board where our Assistant Project Manager, Encik Asrul Abidin must plan each and every move in order not to let any of these machines has time to rest. It was like a war zone with no enemy but the project completion time.

Fortunately, with the support from the project team, the bored pile progressed smoothly. The project was fast ahead of schedule until the sub-structure works starts. Now, the chess game has begun to become more challenging as the arsenals must make way for excavation for the RC sub-structure works.

3xx number of piles, 1xx number of pile caps and 3 number of gigantic liftcore pile cap in 9 months. The team knew that the RC excavation work must be hastened and there was no time for error. However, not every plan A will turn out to be exactly a plan A, the team were forced to have a plan B when they encountered some ground movement while excavating the final liftcore pile cap. Some adjacent bored piles were deviated during the liftcore excavation.

In line with the commitment to deliver a quality work, the management has given full support to abandon the deviated piles and immediately re-mobilised a piling rig to re-construct the affected piles. The project team worked diligently around the clock and received much harassment from the local authority as they fight to complete the work in overdrive. Bravo to the project team as their struggle and perseverance did pay off. They manage to handover the project on the dot.