INTRODUCTION
Kem Semboyan Batu 4 Jalan Ampang consists of one administrative building and two additional blocks of staff quarters. The administrative block is a pre-war colonial type of building and was reported to have experienced cracking of the floor slabs and walls since year 2005. The cracks have since become larger and more pronounced recently.

Approximately 200m north of the building compound, construction works for the SMART Tunnel holding pond is being carried out.

The holding pond was said to be the major factor of the problem. Thus, an independent consultant - Gue and Partners Sdn. Bhd. has been engaged by MMCEG-Gamuda Joint Venture (JV) to investigate the causes and propose the treatment works for the cracks and ground settlement.

Geotechnical Unit of CPKA was requested to review the proposed treatment works suggested by the consultant.

During the site visit, the building was observed to have cracks on the ground floors. The floor was informed to be constructed as non suspended slab. At the time of visit the crack width ranging around 5mm. Anyway, it was observed that only the pre-war building had experienced cracks and settlement.

The extension hall attached to the building was in good condition. No major crack was observed at the venue.

Beside from the cracks on floor slab, the wall of the building also experienced a pattern of cracks. The crack was also reported to be occurred since year 2005.

The SMART Project

"SMART" is an acronym for "Stormwater Management and Road Tunnel". The SMART Project involves the diversion of flood runoff from the catchment area (near the confluence of the Klang River and the Ampang River) through a bypass tunnel before it is directed back to the Klang River downstream. The tunnel also provides an alternative traffic route to lessen traffic congestion at Kuala Lumpur's southern gateway near the Sungai Besi Airfield.

The scope of work involved in the SMART Project consists of these main components:

- the construction of a holding basin in Kampung Berembang, in the Gombak district;
- the upgrading of an ex-mining pond in Taman Desa as a retention pond;
- the construction of a twin box culvert outlet structure (about 500m in length) from the Taman Desa pond to the Kerayong river;
- the upgrading works of the Kerayong river (about 1.8km in length); and
- the construction of related control structures.

The construction of the holding pond is believed to have resulted in the drawdown of the groundwater table. This finding is based on the standpipe readings located at the northern end of Wisma Perwira. The groundwater was observed to have lowered since the commencement of the construction works. The lowering groundwater table would imposed additional load to the ground and thus induces differential settlement. Figure 1 explains the mechanism of failure due to differential settlement.
In addition, 2 nos of additional boreholes and 30 nos of Mackintosh Probes were carried out under the instruction and supervised by personnel of G&P to affirm and reaffirm the adjacent subsurface. Figure 4 shows subsurface profile from the additional boreholes. Figure 5 shows probing layout that indicate relatively soft ground within 3m depth from the surface and becomes stiffer at deeper depths.

RECOMMENDATIONS

General

The particular method to be used would depend on the type of settlement and the extent of any foundation movement and would be determined at the time the problem occurs. Some of the remedial measures available include:

1. Pressure grouting under the foundation which remediates localised settlement of the foundation
2. Densification of the soil by injecting compaction grout into the soil thus forming homogeneous grout bulbs that displace, densify and strengthen the surrounding soil

The consultant had recommended that based on SPT/MP values obtained from site, the estimated length for the bakau pile (if any) are about 3 - 6m. Thus, the grouting work shall be carried at about over 9m below ground level. Basically, a hole will be drill diagonally with an angle to the estimated weak zone at required depth below original ground level underneath column position. The grouting work will be done in stages starting from the lowest level upward.

Initially the process was to let the neat cement to flow due to gravity but due to high silt content at this area, the process is a bit difficult. Thus, a minimum pressure of 0.5bar will be applied to induce the process.

Soil Treatment

At this phase, treatment works involve immediate measures to address the settlement issues and cracking of the prewar building. Controlled pressure grouting works are to be carried out at column locations using neat cement grout. Figure 6 shows the methods of grouting.

The treatment methods are as follows:

1. Locations of grouting works are determined. The grouting works are usually being done at column locations to give extra support or to act as underpinning.
2. Drilling works shall be done at varying angles to reach the different soil layers commencing from softer layers at approximately 30m depth upwards towards the soffit of the building slabs.
3. Upon reaching the target depths, cement grout is pumped into the ground. This process is repeated until all target layers have been fully grouted.
4. Cement grout is a mixture of water and cement at the ratio of 0.5:1 (w:c) with additives (accelerants). The grouting jobs are carried out at controlled pressure of 0.5kg/cm² to avoid heaving of the ground and damage to the existing foundations. The minimum set for grouting is 24 hours. The maximum applied pressure shall not exceed the overburden pressure.
5. Visual monitoring works shall be carried out during the grouting works to detect signs of heaving.

6. The effectiveness of the grouting works would be gauged by re-coring the grout column at the grouted hole. In the event that voids are still detected within the grout column, the grouting works shall be repeated until the grout column is full.

7. With regards to settlements of the non-suspended slab, light weight foam concrete will be pumped to fill the voids between the slab and the ground to ensure full contact of the slab with the ground and shall curb further cracking of the floor slabs.

Cavity Probing and Treatment

Grout may be used to fill large natural cavities underlying engineering structure to prevent or stop subsidence. The size of these openings permits use of a grout containing sand or sand and small gravel, if seepage control is involved a second or a third phase of grouting may be required with the coarser ingredients omitted from the grout to properly seal the smaller voids.

1. Cavity probing works are undertaken within the limestone bedrock using similar approach as described for soil treatment works.

2. Probing locations are put at every column location with angle of drilling limited to not gentler than 20° from vertical.

3. When encountering bedrock, cavities will be probed by lowering the wire line core barrel while at the casing is left in place. This method of works is carried out to prevent against disturbance to the ground which may result in further settlement.

4. If cavities are not detected after coring 5m of continuous limestone, tremie grouting is carried out to seal the bored hole.

5. However, if the cavities are detected, an additional 1m of rock coring below the cavity shall be carried out prior to low pressure grouting.

6. The maximum depth of cavity probing is 40m from the surface and the minimum set for grouting is 24 hours.

7. The grouted hole is re-core thought the grout column and into the limestone until termination criteria is achieved.

8. The initial mixture of grout of water: cement (w:c) ratio is about 1:1 for the first four batches (12 nos 50kg bags of cement) and subsequent mix of w:c of 0.5:1 with additives (accelerants). The initial pressure used is 0.5kg/cm² with maximum applied pressure not exceeding the overburden pressure.

9. Tremie grouting is undertaken for potential slump zone (N=0) above bedrock surface for every grout hole after the treatment of all cavities in each hole and even if no cavities are detected.

10. The treatment result will be reviewed regularly in conjunction with instrumentation monitoring.

11. If the cavities are present in adjacent columns, further cavity probing and treatment will be carried out.

Long Term Monitoring

1. Instrumentation monitoring shall be carried out daily to monitor the settlement of the ground and cracking of the building.

2. The monitoring instruments are as follows:
   - Building Settlement Markers (BSM).
   - Ground settlement Markers (GSM).
   - Demes gauges for cracks width cracking.
   - Standpipes for ground water level monitoring.

3. The monitoring results shall be used for interpretation of the effectiveness of the treatment works.

4. The frequency of the monitoring works shall be reviewed as and where necessary during the duration of the long-term monitoring works.

Acknowledgement:

This Report is written based on the review work done by Unit Geoteknik, CPKA on the “Proposal of Ground Treatment for Ground Settlement and Cracks at Wisma Perwira, Kem Sembayan Bandar, Jalan Ampang, Kuala Lumpur” by Gue and Partners Sdn. Bhd.

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