Chapter III Tin Chung Court - Planning and design

Ground conditions of the Tin Chung Court site

3.1 The TCC site lies in a Scheduled Area [3] where the geology comprises superficial deposits overlying metamorphosed sedimentary rocks. As explained in paragraph 2.11 above, a preliminary site investigation was conducted by Acer for the entire Tin Shui Wai Area 31 in 1994. Owing to the presence of minor marble cavity and local depressions of bedrock, the initial layout plan was modified to re-align the building blocks. A detailed site investigation was conducted by Acer again in late 1995 to investigate the soil conditions beneath the blocks on the revised layout. Altogether, 53 boreholes were sunk by Acer for TCC in the two site investigations.

3.2 According to the Acer Report, the site was reclaimed from fish ponds and was covered by sand fill, estuarine deposits and alluvium totalling about 15 m thick. In between the layer of alluvium and the bedrock was a layer of in-situ decomposed rock with Standard Penetration Test (SPT) N-values [4] generally increasing with depths, ranging from less than 10 to well over 200 near the rockheads at some locations. In the layer of in-situ decomposed rock, "hard pans" of stiff soil underlain by soft layers were noted to be present extensively. The bedrock was located at -26mPD to -50mPD, i.e. 32 m to 56 m below the ground level.

3.3 The locations of the 53 boreholes sunk by Acer for TCC are shown in **Appendix 8**. For the purpose of illustration, **Appendix 9** shows the layers of soil underneath Blocks 1 and 2.

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[3] "Scheduled areas" means the areas specified in the Fifth Schedule to the Buildings Ordinance (Cap. 123). The north-western part of the New Territories (shown on a plan numbered GS-SP/714-1 dated 8 June 1990, signed by the Secretary for Planning, Environment and Lands and deposited in the Land Registry) is one of the areas specified in the Fifth Schedule.

[4] SPT N-value serves as an indication of strength of the soil. It is obtained by a common field test carried out by driving down a standard sampler within a drillhole by a standard weight falling at a standard height. The number of blows required to drive the sampler down by 300 mm is called the SPT N-value. The higher the SPT N-value, the greater the strength is of the soil.

3.4 The two client briefs submitted to BC on 21 September 1995 and 6 December 1995 did not include detailed information about the ground conditions of the site. They only mentioned that the site lay in a Scheduled Area, and the local depressions of the bedrock present in Area 31 might impose restrictions on the choice of foundations and increase cost and time for construction.

Piling design

Choice of piles

Types of piles

3.5 Several types of piles which are accepted by the Building Authority may be used in HA piling projects. They include, amongst others, PPC piles, driven steel H-piles and large diameter bored in-situ concrete piles. For an engineer's design piling project, HD specifies in the tender documents the types of piles and materials to be used as well as the number of piles to be installed and their founding depths, subject to subsequent adjustment by HD in the course of project execution in accordance with the contract provisions. For a design-and-build piling project, tenderers have to propose their piling designs to meet the contract requirements. Tenderers may choose a pile type among those stipulated in the specification comprising general specification (GS) and particular specification (PS). The number of piles to be used and their estimated founding depths are part and parcel of the piling designs to be decided by tenderers.

Piling options recommended in the Acer Report and JMK Reports

3.6 According to the Acer Report, driven piles, including steel H-piles and PPC piles, were feasible piling options for the residential blocks in TCC. As "hard pans" of stiff soil layers underlain by softer seams were present extensively in the site, Acer recommended that driven piles should be installed beyond "hard pans" to avoid excessive settlement problems. Preboring would also be required to install the piles through the "hard pans" as hard driving

might result in the damage of PPC piles. Since the presence of "hard pans" was extensive, Acer commented that the need for preboring would put a heavy demand on the use of preboring machines which were not commonly available in Hong Kong. As much time would be required for preboring, the use of PPC piles might be impracticable. The Acer Report therefore advised that the decision on adopting PPC piles should be carefully scrutinized. The findings in the JMK Reports were largely the same as those in the Acer Report.

Inclusion of PPC piles in the Specification

3.7 As TCC was a design-and-build project, the types of piles permissible for use by tenderers in their piling designs were specified in the Specification. Four types of piles were included in the Specification issued to tenderers on 31 May 1996. They were driven concrete piles including PPC piles, driven steel piles, large diameter bored in-situ concrete piles and steel bearing piles. Noting the difficulties with PPC piles as mentioned in the Acer Report, the Select Committee queried why PPC piles had been included in the Specification in the first place. Different witnesses gave different explanations to the Select Committee. HYA claimed that it had proposed the deletion of PPC piles from the Specification. In the draft PS forwarded by HYA to JMK for comment in April 1996, only large diameter bored in-situ concrete piles and steel bearing piles were permissible for use in the project. It was HD which did not accept its proposal. According to HD staff, HYA had not stated its position in writing. It had been HD's long standing practice to provide tenderers bidding for design-and-build contracts with the maximum flexibility in the use of piles so long as the contract requirements could be complied with. Since PPC piles were not ruled out in the Acer Report, HD should provide PPC piles as a choice for tenderers. HD staff admitted that of all types of piles, PPC piles were the cheapest, and the project estimates for TCC were based on the use of PPC piles. Nevertheless, it was entirely for a contractor bidding for a design-and-build contract to decide which type of piles should be used. The Select Committee does not find any evidence that HYA, HD or any party had objected to the use of PPC piles during the technical assessment of the three lowest tenders which all proposed the use of PPC piles.

Understanding the ground conditions

3.8 Mr SUEN Pak-chiu, Geotechnical Engineer (GE/TCC) of HD responsible for providing geotechnical advice and design parameters during the pre-tender stage, noted that the piling options open to tenderers included large displacement driven piles, such as PPC piles. He suggested to the structural engineers concerned that a pre-tender meeting should be held to brief tenderers on the ground conditions of the site. His suggestion was in line with the agreement reached by HD with the Hong Kong Construction Association that pre-tender meetings should be arranged for Tin Shui Wai piling projects. A pre-tender meeting was held on 22 May 1996, at which the prospective tenderers were given an overview of the geotechnical constraints of the TCC site. Tenderers were not given access to the Acer Report, as it was HD's normal practice not to provide foundation advice reports to tenderers to avoid being placed in a disadvantageous position in possible future claims. Tenderers could however obtain borelog information from the Hong Kong Construction Association or from HD. The Select Committee notes that Franki (B+B) attended the pre-tender meeting and obtained the borelog information on the drillholes sunk by Acer.

Sinking of additional drillholes to assess founding conditions of piles

3.9 At the pre-tender meeting, tenderers expressed concern about the requirement in PS 19.88 to sink 20 confirmatory drillholes at the commencement of the Contract prior to driving works, as the successful tenderer would have very little time to complete these drillholes. HD therefore agreed to sink these drillholes before the commencement of works and to appoint a ground investigation term contractor to undertake the works. Owing to budget constraints, HD's ground investigation term contractor completed only 10 drillholes, numbering HY1 to HY10, by the end of July 1996.

3.10 The fact that HD was carrying out site investigation works was not stated in the tender documents. HD was worried that the inclusion of this additional information in the tender documents after tender-in might lead to contractual complication. HD considered that it remained the Contractor's

responsibility to conduct site investigation if the Contractor considered it necessary. The information on the additional drillholes would be made available only to the successful tenderer after the commencement of the Contract. An addendum to PS 19.88 was issued to tenderers on 4 July 1996, which provided that the Contractor should drill sufficient drillholes to substantiate his design at his own expense. In other words, the additional information on the ground condition was not made available to the tenderers when they prepared their tenders.

3.11 Information shows that Franki (B+B), in the course of the Contract, sank 14 additional boreholes, HY11 to HY24. The sinking of the additional boreholes took place from March onwards until June 1997. Those near or within the footprint of Blocks 1 and 2 were sunk in May 1997. By then all of the piles had been driven. The locations of HY1 to HY24 are shown in **Appendix 10**.

Preboring as a means to overcome underground obstructions

3.12 As to whether the prospective tenderers were aware of the need for preboring if PPC piles were used, the Select Committee notes that HD did draw their attention to preboring as a means to overcome underground obstructions at the pre-tender meeting. Representatives of prospective tenderers had requested that preboring might as well be stipulated in the Specification as mandatory if such was considered necessary, because the price of the Contract would be substantially increased if preboring were a prerequisite. Moreover, as only limited preboring machines were available on the market, it was practically not possible to complete the Contract within the given time if preboring were to be conducted.

3.13 Notwithstanding the views expressed by the prospective tenderers at the pre-tender meeting, preboring was not made mandatory in the Specification to overcome underground obstructions. PS 19.43 stated that when underground obstructions were encountered during the piling operation, the Contractor had to at his own cost and time overcome such underground obstructions by any means he considered practical. The means might include re-designing piles and/or pile caps, or abandoning, extracting, and re-driving

piles, or removing underground obstructions by excavation, or preboring through underground obstructions.

3.14 In this respect, the structural engineers of HD stressed that it was not appropriate to make preboring mandatory, because the need for preboring depended on actual site ground conditions. Whether sufficient preboring machines were available on the market and how "hard pans" should be dealt with were matters for the Contractor to consider. In a design-and-build piling contract, the Contractor had the responsibility to overcome underground obstructions in accordance with the Specification and preboring was one of the specified means.

3.15 The Select Committee notes that twelve tenderers put in bids for the TCC project. In its tender, Franki (B+B) proposed the use of 1,882 PPC piles at an average net length of 26 m for the six domestic blocks. Franki (B+B)'s tender, the lowest among the twelve tenders, was $77.7 million. The second and third lowest tenders were respectively $79.720 million and $80.148 million. They proposed respectively the installation of 1,995 piles at an average net length of 30.34 m and of 1,962 piles at an average net length of 29 m for the six domestic blocks. HD recommended and BC approved the award of the contract to Franki (B+B) at a lump-sum price of $77.7 million for completing the piling contract within nine months from 12 September 1996 to 11 June 1997.

3.16 Franki (B+B)'s tender price was in fact 24.24%, i.e. $24.86 million below the pre-tender estimate of $102.56 million, which was worked out on the basis that PPC piles would be used, taking into account the estimated pile length and the estimated extent of preboring. From a paper submitted to BC in March 1996 for its approval for increasing the project budget for the development in Phases 1, 2 and 3, Tin Shui Wai Area 31, the Select Committee notes that after the availability of detailed site investigation data, HD had estimated that the length of PPC piles should be 38 m and the percentage of piles requiring preboring should be 26%. However, when considering the award of the TCC Contract to Franki (B+B), the estimated length of the PPC piles and the undertaking or otherwise of preboring did not seem to have been taken into account. The average net pile length stated in Franki (B+B)'s

tender was 26 m. In the post-tender letters dated 25 July 1996 and 16 August 1996 from Franki (B+B) to HYA concerning the design calculations of ultimate resistance of PPC piles using static formula, the estimated gross pile length for five of the six blocks was 22 m to 24 m.

3.17 From the evidence given by some individual witnesses, Franki (B+B) calculated the estimated lengths of piles solely by static formula, i.e. based on the calculations of the shaft friction and end-bearing capacity of piles. Franki (B+B) had never considered it necessary to drive the piles to bedrock. Franki (B+B) estimated that by using static formula in calculating the pile length, it was not likely that the founding depth of piles would reach the level at which "hard pans" [5] were present. Preboring had not been taken into account in the estimate from the outset. Although preboring was mentioned as one of the means to overcome underground obstructions in the method statement submitted by Franki (B+B), it was not meant to be used. The Select Committee also notes from evidence submitted by some witnesses to the Court that Franki (B+B) had all along aimed at producing an "aggressive design" so as to "secure the contract" [6].

3.18 The length of PPC piles and the extent of preboring, which were two key factors for calculating the pre-tender estimates, were hardly given any attention by HD when it considered the award of tender. The extent of preboring was not even mentioned in the BC paper which recommended the award of the Contract to Franki (B+B). Moreover, the Select Committee cannot find any evidence indicating HD or BC, when evaluating the tenders, had given sufficient consideration to how the geotechnical difficulties of the TCC site might be overcome.

Government's stipulations on PPC piles founded in Scheduled Areas

3.19 Prior to the TCC project, PPC piles had been used in both HA and private developments in Tin Shui Wai, which lies in a Scheduled Area. Owing to the presence of marble, great difficulties had been encountered in

[5] According to the Acer Report, the depth of preboring ranges from 26 m to 30 m below ground.
[6] See pages 1704 to 1712 of the transcript of the video interview conducted by ICAC with RSE/TCC.

foundation works in both private and public housing development projects in the area. For foundation works in Scheduled Areas, the Government issued a circular on 27 May 1992 (WBTC No. 16/92). According to this circular, the design and construction of works in Scheduled Areas which involve excavation, foundations or groundwater pumping may encounter significant difficulties as a result of the ground conditions. The circular therefore requires all proposed design and construction details of permanent foundation works in Scheduled Areas be submitted to the Geotechnical Engineering Office (GEO) for checking. All foundation construction records, including results of pile driving and pile loading and their analysis are to be submitted as well. This requirement applies to HA projects situated in Scheduled Areas, and hence is applicable to the TCC project.

3.20 In compliance with this requirement, Franki (B+B) submitted the foundation design report for the TCC project to GEO on 18 September 1996. The report stated that due to the existence of hard pans over the site at varying depths, preboring might be required to enable the installation of PPC piles. To minimize undue disturbance to the surrounding soil, preboring should be carried out using the auguring method. GEO confirmed on 23 October 1996 that as the site was not underlain by cavernous marble, it had no major concern on the foundations, and advised that it was not necessary to forward further foundation submissions or documents to it for comment. GEO, nevertheless, stressed the need for adequate supervision during works.

Piling design in the tender

Requirements in the Specification

3.21 According to the Specification of the TCC Piling Contract, piles were designed by the Contractor. PS provided the flexibility for the Contractor to design the piles to any depth so long as the requirements laid down in the Specification were satisfied. In other words, it was not mandatory for the Contractor to found the piles on bedrock or to any given depth. But for piles which were not founded on bedrock, the design of such piles must include settlement calculations based on the design layout and depths of piles to be installed. The relative settlement of piles at the working

load between any adjacent piles must not exceed 1/300 times the distance between the centre lines of the piles [7]. In addition to complying with the extent of settlement, the design of piles not resting on bedrock must also be based on the driving formula (also called dynamic formula) and static formula to achieve the required embedded length of the piles in the bearing stratum [8]. The piles so driven must be able to withstand the designated maximum working load with a factor of safety of not less than two by calculating the skin friction and the end-bearing capacity on the basis of test results obtained during construction.

Piling design before construction

3.22 As explained in the foregoing paragraph, the design of friction piles must satisfy static formula, dynamic formula, static load tests and settlement calculations under the Specification. These calculations, however, can only be verified during and after construction of piles. The piling design in respect of pile length and the method to calculate the ultimate resistance of piles proposed by tenderers in their tender submissions are no more than a proposal.

3.23 The average net pile length proposed by Franki (B+B) in its tender submission was 26 m. Between the tender-in date of 12 July 1996 and the issue of the Letter of Acceptance on 3 September 1996, letters were exchanged between HYA and Franki (B+B) on the method of construction and the method of calculating the ultimate resistance of piles, i.e. skin friction plus end-bearing capacity, by static formula. The Select Committee notes that Franki (B+B) provided on 30 July 1996 an initial set of static calculations to substantiate the estimated length of piles for various blocks. In these calculations, the pile length for Block 1 was estimated at 22 m with the negative skin friction [9] at 3 m. After being reminded that the minimum value of negative skin friction used in these calculations did not comply with the specified figure of 7.5 m in PS 19.31(1), Franki (B+B) revised the value of negative skin friction to 8 m on 16 August 1996. The estimated length of piles however remained at 22 m, but

[7] PS 19.23(1)
[8] PS19.27(2)
[9] The drag-down force acting on the pile shaft produced by the downward movement of the fill in reclaimed land.

the ultimate resistance of piles calculated was even higher than that shown in the letter of 30 July 1996. The two sets of static calculations as shown in Franki (B+B)'s respective letters are in **Appendix 11**.

3.24 The Select Committee has questioned why Franki (B+B) was allowed to increase the ultimate resistance of piles with a higher value of negative skin friction without lengthening the pile. HD's view was that the estimated length of piles and the values adopted were insignificant, because at the end of the day, Franki (B+B) had to prove that the length of the as-built piles complied with the specified criteria. JMK, on the other hand, explained that although a higher end-bearing Nq value was adopted, it still fell within the range of methodologies provided in the references listed in the PS. JMK was therefore in no position to reject the method proposed. The Select Committee notes that the Nq values referred to in the references quoted in the Specification range from 35 to as high as 200. Again, JMK stressed that the actual ultimate resistance of piles could only be verified during construction by dynamic formula and loading tests on working piles.

3.25 The Select Committee notes from evidence submitted to the Court that irrespective of the value of the negative skin friction used by Franki (B+B) in its calculations, the designed length of the piles became shorter and shorter. In the piling layout plans dated 23 September 1996, the gross length of piles was 27 m to 32 m for Block 1 and 31 m to 36 m for Block 2. However, these lengths were reduced to 22 m to 22.5 m for Block 1 and 22.5 m to 23.5 m for Block 2, as shown in the revised piling layout plans dated 11 October 1996 [10].

3.26 The Select Committee finds that despite some efforts had been made from pre-tender site investigations to the completion of the tender exercise to ascertain the ground conditions and identify precautionary measures to deal with the complex conditions, these technical aspects did not appear to have been adequately addressed in the exercise. The information obtained from the site investigations and the precautions identified in relation to "hard pans" and "preboring" were not given sufficient weight throughout the tender exercise. The Select Committee cannot find any evidence which demonstrates vigilance

[10] See pages 81 and 82 of the transcript of the summing-up of the trial

in vetting the piling design proposals in these aspects in the tender bids. The focus, as pointed out in the First Report, was on the price of the tender [11].

3.27 The Select Committee also questioned the use of different Nq values to the Contractor's advantage and the lack of control in this respect. JMK explained that the calculations were approved so long as they were in line with the methodology mentioned in one of the given references in the Specification. The Select Committee however notes that even in one of the given references in the Specification, caution has been sounded against the use of any quoted values [12]. CMW also cautioned that the Nq values derived from the different references stated in the Specification were vastly different and emphasized the need for consistency in the use of references for one project.

[11] See paragraphs 3.40 to 3.43 and 8.7 to 8.9 of the First Report

[12] "Pile Design and Construction Practice", 3rd Edition by M J Tomlinson