

第一节 前言 One Preface

受上海贝岭股份有限公司委托，我院对拟建“上海贝岭股份有限公司 6 英寸集成电路芯片项目”场地进行工程地质勘察工作。

Consigned by Shanghai Beiling Corp.Ltd., Our Institute has done the engineering geological investigation on the site on which Shanghai Beiling Sis-Inch Project is going to be carried out.

一、工程概况 I .General introduction of the project

拟建场地位于上海市张江高科技园区 3-1、3-2、3-3 地块。场地西邻泰隆电子有限公司，东抵哈雷路，北近郭守敬路。场地长约 500m，宽约 150m。

The site is located in Block 3-2, Block 3-3 of Shanghai Zhangjiang High Technology Zone, with Tairong Electronics Co., Ltd. to the east, and Rd.Guoshoujing to the north. The site is 500m in length, and 150m in width.

场地内拟建建（构）筑物分 2 期进行。一期拟建芯片生产主厂房、动力站房各 1 栋，4 层工程师办公楼与餐厅、3 层行政办公楼各 1 栋，以及变电站、水塔、油罐等附属设施。二期拟建生产主厂房、动力站房各 1 栋及气站、水塔、油罐等，总建筑面积 83186m²。各拟建建（构）筑物设计技术参数见表 1。

The building project on the site is to be carried out in two stages. During the first stage, the following shall be finished: one main chip workshop, one engine workshop, one four-storey office building and dining hall, one three-storey administrative office, and other accessories such as the transformer substation, the water tower, the oil can, etc. During the second stage, one main workshop, one engine workshop, and the gas station, the water tower and the oil can, etc. should be finished. It spreads 83186 square meters. The design technical indexes for the buildings are listed in Table 1.

表 1 拟 建 物 性 质 特 征 一 览 表

编 号	建（构）筑物 名称	建筑 面积 (m ²)	结构 类型	层数 或 高度	跨度 (m)	柱距 (m)	基础设计资料				备注
							型 式	埋深 (m)	荷重(kN)		
									最大	一般	
1	芯片生产主厂房	22000	框架	3 层	7.2	7.2	桩基	-2.5 ~	9390	4950	
2	动力站房	4650	框架	2 层	7.2	7.2	桩基		6129	4080	
3	行政办公楼	1000	框架	3 层	7.2	6.0	桩基		3900	2460	
4	工程师办公楼	12000	框架	4 层	7.2	6.0	桩基	-3.5	3900	2460	
5	临时餐厅		框架				桩基		2850	2020	
6	水塔	Φ 8m	混凝土	11m				-5.5			半埋
7	气站	1000									
8	变电站										
9	其它辅助设施										

本工程由信息产业电子第十一设计研究院承担设计。

The Eleventh Design & Research Institute of IT, Co., Ltd. is responsible for the design of the Project.

二、勘察目的及技术要求

II. Investigation purpose and technical requirements

本次勘察属详细勘察阶段，目的是为拟建物的地基基础设计、地基处理和地基施工方案的确提供详细的工程地质资料，并作出分析、评价和建议。具体任务如下：

This investigation is in the detailed phase. The objective is to provide detailed engineering geological data for foundation design, foundation treatment and foundation construction plan of the proposed buildings. In addition, analysis, evaluation and suggestions are made. The detailed tasks are as following:

(1)查明场地内勘探深度以浅各土层岩性特征、分布规律及工程特性。

To examine the geologic features distribution rules and engineering features of the strata within the investigated depth.

(2)提供各地基土层物理力学性质综合指标及地基承载力设计值 f_a 和桩基承载力参数(桩周土极限摩阻力标准值 f_s 、桩端土极限端承力标准值 f_p)。

To provide the foundation soils' comprehensive parameters of mechanical properties, bearing capacity(f_a), and to provide the bearing capacity parameters of the pile foundation (the ultimate standard values of pile side resistance f_s and the ultimate standard numbers of pile top bearing capacity f_p) .

(3)明确场地所属地震基本烈度区域及场地类别，判定场地埋深 15.0m 以浅地基土地震液化势。

To find out the site class and its basic seismic density, and judge the seismic liquefaction potential of the subsoil above 15.0m.

(4)简述场地地形、地貌特征。

To briefly describe the site's landform and geomorphology.

(5)调查场地浅部地下水埋藏条件，并评价其对混凝土的腐蚀性。

To investigate the embedment features of the shallow underground water ,and to evaluate its corrosion to the concrete.

(6)提供防微振动分析需要的有关土的动力特性参数。

To provide the soil's dynamical feature parameters for the small vibration prevention.

(7)按网格进行场地导电性能测试，为接地、防雷设计提供依据。

To test the site electricity conductivity according to the grid, and provide the information for the grounding and lightening proof design.

(8)评述场地工程地质条件，根据各拟建建（构）筑物特征，对各拟建建（构）筑物基础

形式作出评价及建议：对天然地基，建议基础持力层及基底设置标高；对桩基及复合桩基，建议合理的桩型、桩端持力层、桩长及桩径等，并估算单桩竖向承载力。对预制桩，评价沉桩可能性。

To describe the site's engineering geologic conditions and evaluate the buildings' base forms according to their corresponding features. To suggest the sustaining stratum and the base altitude for the natural foundation; For the pile foundation and complex foundation, to suggest suitable pile types, pile end's sustaining strata, pile length and pile diameters, and to calculate the vertical sustaining force for the single piles. In addition, to give the settlement possibility for the precast piles.

(9)提供地基变形计算所需岩土参数。

To provide the geologic parameters needed for the foundation transformation calculation.

(10)评价水塔、油罐基坑开挖条件，初步建议基坑设计方案，提供基坑围护设计所需岩土参数。

In addition, to give the dredging conditions of the foundation of the water tower and the oil can; to give elementary plans for the foundation pit designing; and to provide the geological parameters for the enclosure and designing of the foundation pit.

三、执行的主要技术标准

1. 国家及上海市标准《工程建设标准强制性条文——房屋建筑部分》；

Compellent Articles of Engineering Construction Standard(part of house building), Sate Standard

2. 上海市工程建设规范《岩土工程勘察规范》(DGJ08-37-94);

Geotechnical Investigations Code DGJ08-37-94, Shanghai Engineering Construction Standard

3. 上海市工程建设规范《地基基础设计规范》(DGJ08-11-1999);

Foundation design Code DGJ08-11-1999,Shanghai Engineering Construction Standard

4. 上海市工程建设规范《建筑抗震设计规程》(DGJ08-9-92);

Building Aseismic Design Code DGJ08-9-92, Shanghai Engineering Construction Standard

5. 上海市工程建设规范《基坑工程设计规程》(DGJ08-61-97);

Foundation Pit Engineering Design Code DGJ08-71-97, Shanghai Engineering Construction Standard

6. 上海市工程建设规范《地基处理技术规范》(DGJ08-40-94);

Code for Profundity of Geotechnical Investigation DGJ08-72-98, Shanghai Engineering Construction Standard

7. 上海市工程建设规范《岩土工程勘察文件编制深度规定》(DGJ08-72-98);

Technical Code for the Foundation Treatment DGJ08-40-94, Shanghai Engineering Construction Standard

8. 行业标准《静力触探技术标准》(CECS04:88);

Technical Standard for Cone Penetration Test CECS04:88, Trade Standard

9. 国家标准《土工试验方法标准》(GB/T50123-1999);

Standard for soil Test Method GB/T50123-1999, State Standard

10. 行业标准《中华人民共和国地质矿产部直流电法工作规范》;

Working Criterion for the Direct Current Method by the Geology Mine Department of PRC, Trade Standard

11. 行业标准《场地微振动测量技术规程》(CECS74:95)。

Technical Code for Site Vibration Measurement CECS74:95, Trade standard

四、勘察手段及完成工作量

本次勘察工作按《勘察投标书》，并根据业主于 2001 年 3 月 23 日提供的最新建筑总平面布置图进行调整后执行。勘察全过程严格按照本院根据 ISO9002 质量保证体系编制的程序文件执行，施工质量优良。

This investigation is adjusted and carried out according to *Investigation Bid Document*, and the latest *Plane Location Plan* provided by the owner on March 23, 2001. This investigation is carried out strictly according to the process control documents in line with the ISO9002 quality assurance system implemented by our Institute. The general engineering quality is excellent.

本次勘察采用钻探取样、原位测试（静力触探试验、标准贯入试验、平板载荷试验、场地微振动测试）及室内土水试验相结合的多种勘探测试手段。

The investigation used a combination of bore sampling, in-situ tests (CPT, SPT, plate loading test, and site micro-seisms test) and lab tests.

1、钻探 boring

本次勘探钻孔采用 XY-1 型液压回转钻机完成，采用泥浆护壁全岩芯钻进，分回次钻进取芯、做标准贯入试验及采取不扰动土样。小螺纹钻孔采用人力手摇式螺纹钻具完成。

This exploration drilling was done with hydraulic rotary drill rig XY-1 in the way of mud flush drilling. Cores were taken in way of rotary progress for SPT and taking of undisturbed soil samples. Small holes were drilled with manual augers.

2、原位测试 in-situ tests

静力触探试验：静力触探孔由 SY-10、MJ-II 型静探仪完成，采用单桥探头反映土层在不同深度的变化情况，由专用微机采集、记录数据并形成 P_s 值随深度变化的连续曲线。

In CPT, the single bridge probe of SY-10 and MJ-II model cone penetration instrument penetrates, the special PC collects and records data and works out automatically the continuous curve of P_s vs depth.

标准贯入试验：采用 63.5kg 落锤，落距为 76cm，自动脱钩自由下落，先击入 15cm 记录

预击击数，再记录后 30cm 中的每 10cm 的锤击数。

In SPT, a 63.5kg heavy hammer was used, and the falling height was 76cm. The hammer is automatically unhooked and for free falling. Strikes were counted for the first 15cm. Then, for the following 30cm, the strikes were counted for each 10cm.

平板载荷试验：本次勘察于场地内布置 2 组平板载荷试验点（PLT1、PLT2），试验采用以堆载平台为反力系统，通过油压千斤顶进行逐级加、卸载，并由荷重传感器及电子数字显示器反映荷载，使用安装在刚性基梁上的机械百分表进行压板的沉降和回弹变形观测，承压板为 $0.7\text{m} \times 0.7\text{m}$ 的刚性铁板，试验方法为分级维持荷载沉降相对稳定法（常规慢速法）。

In PLT 2 sets of PLT points (PLT1 and PLT2) were set up. The reaction system was by a weight platform and reaction loading and unloading is applied in equal increments by a hydraulic jack. The load measurement was done with the load sensor reporting the data to an electronic monitor. The settlement measurement and rebound deformation was done with a mechanical dial gauge installed on the rigid reaction beam. The loading plate used was a rigid metal plate at size $0.7\text{m} \times 0.7\text{m}$. The testing method was incremental loading test with relatively stable settlement (normal and slow method).

场地微振动测试：本次勘察于场地内选取二个试验点 T1、T2 点进行场地微振动试验，以提供建筑场地卓越周期和微振动速度幅值。试验采用 65 型地震仪将地微振动速度转变成相应的电信号，并输入到 DF-1 型五线工程测振仪，经放大后的地微振动速度信号再输入到 CRASV4.2 数据采集与处理系统作进一步分析处理。由打印机将测试分析结果打印在记录纸上。根据每个测点三个方向各采集 10 个数据，采集数据的时间间隔为 1~2 分钟，实测有代表性的地微振动速度~时间曲线、富氏谱图，经计算分析得场地卓越周期、地微振动速度幅值。为比较正常、安静环境不同工况下地微振动的差别，对 2 测点的测试时间，一次安排在 2001 年 3 月 23 日下午 1:00~3:00（正常环境）；另一次安排在 2001 年 3 月 24 日凌晨 1:00~3:00（安静环境）。

Site micro-seisms test: two testing points (T1 and T2) were selected in the Site for the micro-seisms test, so as to provide the predominant period of the site, speed and amplitude of the micro vibration. During the test the Model 65 seismic device was used to transfer the micro vibration speed into electronic signal and then entered to DF-1 engineering seisms prospecting device. The signal is amplified and then entered to CRASV4.2 data collection and processing system for further analysis. The analysis results are printed to the recording paper. Ten data for each of the three directions on each testing point were collected and the time interval was 1-2 minutes. The predominant period and speed and amplitude of the micro vibration are calculated based on the representative curve of micro vibration speed versus time and the Fourier spectrum. In order to compare the micro vibration in the relatively normal and quiet environment, we tested twice on Testing Point 2. One was at 1:00~3:00pm on March 23rd 2001 which was in the normal environment, and the other was at 1:00~3:00am on March 24th 2001 which was in quiet environment.

土壤电阻率测试：为测定本工程场地浅层土壤的接地和防雷的导电性能，进行了土壤电阻率测试，共完成 15 个电测深物理点（共 240 个测试点）、检查物理点 1 个。本次测试采用对称四极电阻率测深法，其原理是利用地下地层存在的电性差异，通过向地下供应的人工电场，改变供电电极距，在地表逐一测量出各电极距的电位差 ΔV 和供电电流 I ，求得相应的视电阻率值，从而得出每一电测深点随深度变化的视电阻率曲线，对这曲线进行圆滑并用量板作定量解释，求取各电性层的厚度和电阻率值，最后用加权平均法计算出不同深度的土壤电阻率（ ρ ）。测试仪器用 ZWD-2 型直流数字电测仪，供电电极距 $AB/2=0.3\sim 50.0\text{m}$ ，测量电极距 $MN/2=0.1\sim 2.0\text{m}$ 。

Soil resistance test: In order to find out the conductivity of earthings and lightening proof devices in the shallow strata of the site, 15 electrical sound physical points (240 testing points) and 1 physical point are finished. Quadrupole resistivity sound method is used in this test. The underlying theory is as following: first, change the electrode distance by making use of the electric difference in the underground strata, and of the artificial electrical field supplied to the underground area. Second, on the surface measure the electrical potential difference ΔV and electrical current of supplying electricity I , so that the corresponding resistivity can be found, and the curve of resistivity vs depth for every electrical sound point can be made. Third, round the curve and give quantity explanation with rules, and thus the depth and the resistivity of every electrical stratum for each electrical stratum can be gotten. Finally, calculate the soil resistivity ρ of soils in different depth by the means of arithmetic mean. ZWD-2 direct current digital instrument is used as the measuring equipment. Electrode distance of supplying electricity $AB/2=0.3\sim 50.0\text{m}$, and electrode distance of measurement $MN/2=0.1\sim 2.0\text{m}$.

3、室内土、水试验 lab soil and water test

常规试验：对所取的不扰动土样均进行常规测试；对粉性土、砂土不扰动土样及扰动土样还进行颗粒分析试验；⑥层不扰动土样固结试验加压至 800kPa，⑦层不扰动土样固结试验加压至 1200kPa。选取②、③、④、⑤₁层部分土样进行无侧限抗压强度（ q_u 、 q_u' ）试验，选取②、③、④层不扰动土样进行室内渗透（ k_v 、 k_h ）试验。

Conventional tests: the undisturbed soil sample underwent conventional tests. Both the disturbed and undisturbed silt and silty sand samples underwent grain size analysis test. Undisturbed soil samples of Stratum⑥ were loaded with a pressure of up to 800kPa, while the soil samples of Stratum ⑦ were loaded with the pressure of up to 1200kPa. Part of the soils samples from Strata ②, ③, ④, and ⑤₁ underwent unconfined pressure test (q_u , q_u'). Undisturbed soils samples from Strata ②, ③, ④ underwent lab penetration test (k_v , k_h).

共振柱试验：根据工程需要，于场地内选取了 16 个不扰动土样进行共振柱试验，测定地基土动力特性参数，即动剪切模量 G_d/G_0 （初始动剪切模量）、扭转振动阻尼比 D 随动剪应变 γ_d 的变化曲线。测试仪器采用从美国引进的V.P.Drnevich共振柱仪，试样直径 $\phi=35.7\text{mm}$ ，

高度 $H=71.1\text{mm}$ 。试样用抽真空的方法达到饱和， B 系数严格控制在 0.97 以上，对试样施加的各向均等有效固结压力（即有效围压 σ_{3c}' ）取土样实际所承受的有效上覆压力，试样排水固结完成（孔隙水压力消散）后，关闭排水阀门，然后对试样施加扭转激振力矩。根据试验中测得的试样系统的共振频率，自由衰减振动曲线，加速度传感器的输出及试样的几何特性等分别计算得 G_d/G_0 、 $D \sim \gamma_d$ 关系曲线。

Resonant column test: as required we selected 16 groups of undisturbed soil samples to do the resonant column test so as to measure the foundation soil's dynamic feature index, such as the dynamic shear module G_d/G_0 (initial dynamic shear module), the curve of torque vibration resistance D versus dynamic shear stress γ_d . The measurement device was V.P.Drnevich resonant column device imported from the US. The diameter of the sample was $\phi = 35.7\text{mm}$, and the height was $H=71.1\text{mm}$. The sample was vacuumed to saturation and the factor B was strictly controlled to be above 0.97. Isotropic effective consolidation pressure (effective pressure σ_{3c}') adopted the actually applied effective value. After consolidation finished (when the pore water pressure dissipated) the water pipe was closed. The sample was then applied consonant torque. The curve of G_d/G_0 and $D \sim \gamma_d$ was then derived from the measured consonant frequency, the vibration free attenuation curve, the output of the acceleration sensor and the geometry features of the samples.

动侧压力系数试验：于本场地内取 16 个不扰动土样进行动侧压力系数试验，实测土的动侧压力系数 K_{od} 值。试验采用TK-1 型动态侧压力系数仪，仪器的竖向动、静力施加设备采用CKC循环三轴仪的加荷系统，土样压力室为刚性密封式容器，土样面积 30cm^2 ，土样高度 6.4cm 。试验求得各试样动侧压力系数 K_{od} ，并导出动泊松比 μ_d 与动剪切模量 G_d 。

Dynamic lateral pressure coefficient test: 16 undisturbed soil samples are prepared for the dynamic lateral pressure coefficient test in order to get the coefficient K_{od} . The TK-1 type of testing device was used and the lateral dynamic and static pressure was applied by the loading system of CKC cycling tri-axle device. The sample pressure cabinet was a rigid and sealed container. The surface area of the sample was 30cm^2 and the height was 6.4cm . The dynamic lateral pressure coefficient K_{od} of each sample was calculated after the testing and hence the Poisson's ratio μ_d and dynamic shear module G_d were derived.

水质分析：为判别地下水对建筑材料的腐蚀性，本次勘察分别在Z17、J22 孔旁各取地下水样 1 组进行水质简分析+侵蚀性 CO_2 分析。

Hydro-chemical analysis: in order to judge the water corrosion to building material we took 2 sets of water sample from respectively the bore holes Z17 and J22. The samples underwent water quality and corrosive CO_2 analysis.

4、勘探点测量定位 setting out of exploration holes

各勘探点实地放样根据勘探孔平面布置图，以郭守敬路 GPS2、GPS3 点为基准点及各勘探孔平面坐标，采用 SET500 型全站仪进行测定。施工结束后用全站仪测定了各勘探孔孔口高程，

高程引测点为 BM，该点位于场地西北面——龙东大道、金科路路口东南侧绿地内，吴淞高程为 4.6212m。

Setting out of the exploration holes was based on the plane plan of the exploration holes taking the Points GPS2 and GPS3 as benchmarks with the SET500 model total station device. The altitude of each exploration hole surface was measured with a level after exploration. The benchmark was Point BM to the northwest of the Site which was located in the green belt in the southeast part of the intersection between Longdong Rd. and Jinke Rd marked by an iron nail in front of the existing Main Station (transformer substation). Its Wusong altitude is 4.6212m.

5、完成工作量 actual quantities of work done

勘察外业施工自 2001 年 3 月 23 日进场，至 2001 年 3 月 28 日结束，开动 XY-1 型钻机 4 台，MJ-II 型静力触探车 1 台、SY-10 型静探车 2 台及人力小螺纹钻具 3 台，施工总历时 6 天。并同时进行天然地基竖向平板静载荷试验（2001 年 3 月 29 日～4 月 3 日）、场地微振动测量（2001 年 3 月 23 日～24 日）及土壤电阻率测试（2001 年 3 月 25 日～26 日）。野外工作总历时 12 天。

Field investigation began on March 23rd 2001 and ended on March 28th 2001. The exploration lasted 6 days. Four sets of XY-1 drill rig, one set of MJ-II and 2 sets of SY-10 cone penetration machines as well as 3 sets of manual augers were used in the field investigation. At the same time a few field tests were made including the vertical plate loading test for the natural foundation (from March 29th to April 3rd), the site micro-siesms measurement (from March 23rd to March 24th), and the soil resistance test (from March 25th to March 26th). The field work lasted 12 days.

本次勘察共完成钻孔 23 个，静力触探孔 45 个，小螺纹钻孔 216 个（详细工作量见表 2）。

A total of 23 drilling holes, 45 cone penetration holes and 216 small holes were made in the field investigation. Please refer to Table 2 for the details of work quantities.

表 2 勘 探 工 作 量 一 览 表

项 目				项 目			
项 目		单 位	数 量	项 目		单 位	数 量
钻 探	孔数	个	23	水 土 测 试	常规试验	个	260
	进尺	米	956.47		颗粒分析	个	131
静 探	孔数	个	45		室内渗透试验	组	28
	进尺	米	1791.20		加压(800kPa)固结试验	组	32
小钻孔	孔数	个	216		加压(1200kPa)固结试验	组	45
	进尺	米	864.00		无侧限抗压强度	组	19
取 样	不扰动土样	个	260		测地下水 PH 值	组	23
	扰动土样	个	55		水质筒分析	点	2
	水样	组	2	测 量	定点放样	点	384
标准贯入试验		段次	55		高程测量	点	384
平板载荷试验		点	2		潜水位测量	条	23
测土壤电阻率		测试点	241	场地微振动试验		点	2

第二节 场地工程地质条件

Two Site Engineering Geological Conditions

一、地形地貌特征及场地现状

I .Geomorphology and landform features and site situation

拟建场地属长江三角洲入海口东南前缘滨海平原，地貌类型单一，地形平坦。根据各勘探孔孔口高程测量结果：场地各勘探孔所涉及的自然地面标高(吴淞高程，下同)为 4.25～2.96m，平均约为 3.7m。

The proposed Site is of coastal plain of the southeast front of the Yangzi River Delta. The geomorphology type is simple and the landform is flat. The height measurement results of the exploration hole surface shows that the natural surface elevation (Wusong Altitude system, same as below) of the surface of the exploration holes is 4.25～2.96m, and the average elevation is 3.7m.

场地原为农村居住、生活区，原有住宅已基本拆除。场地地势除西北侧局部填土略高外，基本保持原有地貌形态。

The site was originally the countryside living areas. The buildings were nearly removed. Except that some filling on the northwestern parts is slightly higher, the rest remains in the original geomorphology shape.

场地发育有数条河浜，主体走向为东西向与南北向，浜中积水，但水体基本无外部联系，处于滞流状态。

There exist a couple of rivers and ponds in the site. The rivers mostly run from the east to the west, and from the south to the north. In ponds remains some still water that basically is isolated.

二、地基土的构成与特征

II .The components and features of the foundation soil

拟建场地勘探深度范围内各土层均为第四系松散沉积物，整个场地主要由饱和粘性土及粉土等组成。根据地基土的成因、结构及物理力学指标，按照《岩土工程勘察规范》（DGJ08-37-94）附录 B，将本场地 50.77m 以浅揭露的地基土划分为 10 个层次、1 个透镜体。土层层序基本完整，层位相对稳定。

The foundation soils within the exploration depth are loose alluvial of Quaternary age. The soils are mainly composed of saturated clay and silt. Based on the Annex B of the *Technical Specification of Geotechnical Engineering Investigation DGJ08-37-94* we divided the subsoil disclosed within 50.77 on site into 10 strata and 1 lentoid according to their formation age, cause and physical properties. The soil sequence is basically complete and the stratum position is

basically stable.

各土层纵横构成、分布特点见工程地质剖面图，地基土特征见表 3。

The stratum structure, distribution features are listed in the Engineering Geological Section, the foundation soil in Table 3.

三、地基土物理力学性质

III.The comprehensive parameters of the foundation soil's mechanical properties

根据地基土层划分结果，以各地基土层为统计单元，对地基土物理力学性质指标进行分析，剔除个别明显不合理偏值后，采用 10% 舍去法进行分层统计，求得各地基土层物理力学性质统计指标（包括平均值、统计样本数与最大、最小值及变异系数，标准贯入实测击数及颗粒分析指标提供平均值，静力触探试验 P_s 值提供最小平均值），其中直剪固快 C_k 、 ϕ_k 指标经 $\tau - P$ 曲线综合指标修正，统计结果见表 4。

As the foundation soil strata are taken as the statistic units, the comprehensive indexes of the mechanical properties of the foundation strata have been obtained by analyzing the foundation strata's indexes, dropping the obviously unreasonable diverging numbers and adopting 10% rounding methods in the strata statistics. The comprehensive indexes of the mechanical properties of the foundation soil strata include the statistics sample numbers, the average, max, min, variance coefficient, and the average value of the particle analysis indexes. Among them, direct shear consolidation indexes C_k 、 ϕ_k have been modified by curves $\tau - P$ comprehensive indexes. All are listed at Table 4.

各土层物理力学性质指标变异性一般为很低～低，说明分层较为合理，各指标能代表相应土层的特征。

The mechanic property index of the soils has very low or low variance coefficient, which proves that the stratum division is accurate and the index can represent the features of the corresponding stratum.

其中⑦₁₋₁层根据野外揭示土层特征及室内土工试验成果，采用综合定名法定名。

Stratum ⑦₁₋₁ is named under the comprehensive naming system according to the features of the uncovered stratum in the field and the results of the lab water soil test.

四、地下水 IV.Groundwater

场地浅部地下水属潜水类型，主要补给来源为大气降水及地表迳流。勘察结束后，于钻孔中统一测量的地下水稳定水位为 3.24~2.78m 左右。结合有关规范：本场地常年平均地下水位埋深可取 0.50m。

The shallow underground water is the type of the phreatic water. It mainly comes from the precipitation and surface runoff and discharges through surface evaporation. After exploration the

stable water level in the bore hole were measured around 3.24~2.78m. According to the data for this region and the relevant codes, the average perennial embedment depth of the underground water can take 0.5m.

据调查，本场地未曾有污染历史，且场地及附近也未发现地下水污染源存在，根据于场地内采取的 2 组地下水试样（W1、W2）分析成果及现场采用 PH 广范试纸对钻孔揭露浅部地下水进行测试，结果：本场地浅部地下水 PH 值 ≈ 7 ，呈中性，根据《岩土工程勘察规范》（DGJ08-37-94）判定：本场地浅部地下水对混凝土无腐蚀性。

The reconnaissance result shows that the site has not been polluted and during exploration no pollution source in the site or nearby was found. The analyzed testing results of two sets of groundwater samples (W1, W2), and pH universal indicative paper showed that pH value of the water is about 7. We judged according to the *Technical Specification for Investigation of Geotechnical Engineering DGJ08-37-94* that the underground water and foundation soil is not corrosive to concrete.

五、明、暗浜（塘）及地下障碍物分布情况 V. The distribution of drain mles and consolidation

场地位于原农村居住区，场地内明浜分布较广，主体走向为东西向、南北向，宽 6~18m 不等，浜底原状土顶面埋深约 2.6~3.6m；浜底淤泥厚度约 1.0~1.8m，含大量有机质及少量生活垃圾。施工期间，场地内明浜基本已被后期施工截断，北段河浜正予以清淤，局部被堆填形成暗浜。

The site was originally the countryside living areas. There are wide distributions of rivers, that mainly run flow the east to the west, and from the south to the north, with width varying from 6~18m. The embedment of the original soil top under the rivers are about 2.6~3.6m; the slush is about 1.0~1.5m thick, containing a lot of organic substances and some trashes. During the construction, all the rivers were basically obstructed; and the rivers in the north parts are being cleared, some were filled to become the drain moles.

场地东侧拟建主厂房及二期动力站房分布有暗浜，暗浜宽 6~18m，深 2.6~3.6m，暗浜充填物主厂房部分以粘性土为主，含大量黑色有机质，二期动力站房部分为新近建筑垃圾充填，含大量碎砖石，成分杂，力学性质极差，均不能直接作拟建物的基础持力层。

To the west of the site, there is a dark pond around the proposed production hall and the second-phase power station, which is 6~18m in width, and 2.6~3.6m in depth. The pond refill is mainly clay with large contents of black organic matters in the main production hall and new construction garbage with many broken bricks in the second-phase power station. They are of poor mechanical properties and can not serve as the foundation sustaining layer for the proposed buildings.

本场地内除动力站房、变电站及一期水塔、油罐不涉及暗浜外，其余拟建物都不同程度地涉及明、暗浜（明、暗浜具体分布范围见图 1）。

Except the engine room, the transformer station, the water tower and the oil can of the first stage, all the buildings are, to various extents, on plain or dark ponds. Refer to Figure 1 for the detailed ponds and rivers distribution.

本次施工的勘察孔未遇地下障碍物。

No underground obstacles are met during this construction investigation.

六、场地和地基土的地震效应

根据《建筑抗震设计规程》（DGJ08-9-92）有关条文，本场地位于地震基本烈度 7 度区，场地土类型为软弱场地土，建筑场地类别为 IV 类，处于对建筑抗震不利的地段。

According to *Technical Specification for Building Seismic Design* DGJ08-9-92, the anti-seismic intensity of the site is 7 degree, the foundation soil is of soft type. The site belongs to Type IV, which is unfavorable for anti-earthquake.

场地埋深 15m 以浅存在呈透镜体状分布于③层淤泥质粉质粘土中的③_夹层粘质粉土层，按照《地基基础设计规范》（DGJ08-11-1999）及《建筑抗震设计规程》（DGJ08-9-92）相关要求，本场地地基土在地震烈度 7 度条件下，不会发生砂土液化。

There is distribution of lentoid Stratum③_{inter} which is cohesive silt in the Stratum③ mucky silty clay within 15m depth in the Site. According to *Technical Specification for Foundation Design* DGJ08-11-1999 and *Technical Specification for Building Seismic Design* DGJ08-9-92 no sand liquefaction will happen to the foundation soil of the site when the anti-seismic intensity is 7 degree.

根据现场地微动测试及室内共振柱、动侧压力系数试验结果，对有关参数统计整理如下（详见表 5、表 6）：

Please refer to Tables 5 and 6 for the data and indexes of the site micro-seisms test, lab consonant column test, and the dynamic lateral pressure coefficient test.

七、场地土壤电阻率 soil resistivity

根据委托要求，本次工作于场地内布置了 15 个电测深物理点（共 240 个测试点），1 个检查物理点（见附图）进行试验，结果：本场地土壤电测深曲线类型主要以 QH 型为主，可分为 4 个电性层，第一电性层的电阻率高于第二电性层，主要反映为表层浮土的电性特征；第二电性层主要反映为淤泥质粉质粘土层的电性特征；第三电性层相对较低，主要反映为淤泥质粘土层的电性特征。

表 5 实测卓越周期、微动速度幅度汇总表

环境	测点	方向	卓越周期 (s)	微动速度幅值 (mm/s)
正常环境	1	垂直	0.251	6.5E-2~11.7E-2
		东西向水平	0.367	13.5E-2~25.5E-2
		南北向水平	0.379	11.6E-2~21.9E-2
	2	垂直	0.256	6.0E-2~10.8E-2
		东西向水平	0.346	14.1E-2~21.9E-2
		南北向水平	0.365	10.3E-2~22.6E-2
安静环境	1	垂直	0.275	1.7E-2~4.5E-2
		东西向水平	0.384	2.4E-2~6.5E-2
		南北向水平	0.392	3.1E-2~7.2E-2
	2	垂直	0.272	1.4E-2~3.7E-2
		东西向水平	0.362	2.7E-2~6.4E-2
		南北向水平	0.380	2.9E-2~6.7E-2

表 6 土的动力参数测试结果汇总表

层号	土层名称	试样深度 (m)	动侧压力 系数 K _{od}	动泊松比 μ_d	初始动剪 切模量 G ₀	拟合参数	
						ar	br
②	褐黄色粘土	1.35	0.54	0.35	24.22	0.01598	27.73436
③	灰色淤泥质粉质粘土	8.30	0.71	0.42	31.13	0.03213	38.76249
④	灰色淤泥质粘土	12.45	0.75	0.43	30.54	0.03282	34.52384
		16.80	0.70	0.41	39.98	0.02506	28.50195
⑤ ₁	灰、褐灰色粉质粘土	21.35	0.63	0.39	67.55	0.01489	19.00692
⑥	暗绿~褐黄色粉质粘土	25.80	0.56	0.36	110.81	0.00903	10.52136
⑦ ₁	草黄、褐黄色砂质粉土	35.10	0.48	0.33	144.72	0.00691	5.41025
⑦ ₂	灰黄色粉砂	45.00	0.42	0.30	168.88	0.00590	5.20053

As required, 15 electrical sound physical points (240 testing points altogether) and 1 examination physical point (refer to attachment) were drilled. The testing results are as follows: the curve type of the soil's electrical sound is mainly QH; 4 electrical strata are found; the resistivity of the first electrical stratum is higher than that of the second one; the electrical feature of the floating soil is reflected in the first stratum. The electrical features of the mucky silty clay are reflected in the second stratum. The third electrical stratum is comparatively low, and the electrical features of the mucky clay are reflected.

埋深 10m 以浅土壤电阻率由浅到深呈逐渐变小的趋势:

- 1、1m 以浅的土壤电阻率值为 21.0~35.2 $\Omega \cdot m$, 平均值为 26.1 $\Omega \cdot m$;
- 2、2m 以浅的土壤电阻率值为 19.0~26.8 $\Omega \cdot m$, 平均值为 22.5 $\Omega \cdot m$;
- 3、3m 以浅的土壤电阻率值为 17.9~25.1 $\Omega \cdot m$, 平均值为 21.1 $\Omega \cdot m$;

4、5m 以浅的土壤电阻率值为 12.5~23.6 $\Omega \cdot m$ ，平均值为 19.7 $\Omega \cdot m$ ；

5、10m 以浅的土壤电阻率值为 8.4~19.1 $\Omega \cdot m$ ，平均值为 15.3 $\Omega \cdot m$ 。

八、平板载荷试验

VIII. Plate loading test

根据委托要求，本次工作于场地内布置 2 组平板载荷试验点 (PLT1、PLT2)，试验按《地基基础设计规范》(DGJ08-11-1999) 有关规定执行，采用堆载法进行试验，压板面积为 0.5m²，置换率为 1.000，试验测得天然地基极限承载力分别为 135kN、130kN。

According to the consignment requirements, two sets of plate loading test spots (PLT1、PLT2) are positioned. The test has been carried out according to Code DGJ08-11-1999, with the loading method. The board pressed area is 0.5 square meters, and the permutation rate is 1.000. The results indicate that the ultimate bearing capacity of natural foundation are respectively 135kN and 130kN.

第三节 地基土分析与评价

Three Analysis and evaluation of the foundation soil

一、地基承载力设计值

I .Ground's bearing capacity

天然地基承载力设计值根据《地基基础设计规范》(DGJ08-11-1999) 中第 4.2.3 式及静力触探相关公式计算，并结合现场平板载荷试验成果与地区建筑经验提供(见表 7)。计算时假定：

The bearing capacity is calculated according to Article 4.2.3 of Code DGB08-11-1999, the relative cone penetration formula, the plate loading test results and the construction experience in the area (refer to Table 7). The following are postulated when calculating:

1.常年地下水位埋深取 0.50m； the underground water's usual embedment is 0.50m;

2.基底砌深 $d=1.00m$ ； foundation depth $d=1.00m$;

3.基础宽度 $b=1.50m$ 。 foundation width $b=1.50m$;

本报告提供的地基承载力设计值仅用于评价地基土的工程特性，具体设计时，应根据实际基础形状、尺寸和埋深条件，并考虑下卧层强度后，按表 4 中的有关指标，运用规范中提供的公式及静力触探相关公式计算确定。

The foundation bearing capacity provided in this report is just for reference in the foundation soil evaluation. The designer shall calculate according to the relative indexes in Table 4, No. DGJ08-11-1999 and the relative cone penetration formula, according the actual foundation shape,

size, embedment conditions and the underlying stratum's strength.

二、桩基设计参数 II. Bearing capacity parameters of pile foundation

依据各地基土物理力学性质指标，结合各土层岩性特征及埋藏条件，根据《地基基础设计规范》（DGJ08-11-1999）及《岩土工程勘察规范》（DGJ08-37-94）中有关公式计算、查表，结合经验确定桩基承载力设计参数（见表 7）。

According to the mechanical property indexes of foundation soil, the soils' geotechnical features, embedment conditions, the relative formula and tables in Code DGJ08-11-1999 and Code DGJ08-37-94, in addition to experience, the bearing capacity parameters of pile foundation are listed as follows (Table 7).

表 7 地基承载力设计值及桩基承载力参数表

层号	土 层 名 称	层顶一般埋深 (m)	平均比贯入阻力 Ps (MPa)	平均标准贯入击数 N (击)	地基承载力设计值 f _d (kPa)	预 制 桩		钻孔灌注桩	
						桩周土极限摩阻力标准值 f _s (kPa)	桩端土极限承载力标准值 f _p (kPa)	桩周土极限摩阻力标准值 f _s (kPa)	桩端土极限承载力标准值 f _p (kPa)
②	褐黄色粘土	2.3	0.76		110	15		15	
③	灰色淤泥质粉质粘土	8.0	0.56		75	6m 以浅 15 6m 以深 20		6m 以浅 15 6m 以深 16	
③ _夹	灰色粘质粉土	6.0	2.34	6	130	15		15	
④	灰色淤泥质粘土	11.5	0.61		70	20		16	
⑤ ₁	灰、褐灰色粉质粘土	19.8	1.10		100	45		35	
⑥	暗绿~褐黄色粉质粘土	28.8	2.47		150	80	27m 以浅 1500 27m 以深 2500	65	
⑦ ₁₋₁	褐黄色砂质粉土夹粉质粘土	30.5	6.61	23		85	3000	70	1000
⑦ ₁₋₂	褐黄、草黄色砂质粉土	36.5	10.51	35		95	5000	75	1700
⑦ ₂	灰黄色粉砂	>50.0	15.60	56		110	6500	90	2200

三、地基变形估算所需岩土参数

III. The geotechnical parameters needed for the foundation transformation

根据各地基土层土工试验及原位测试综合成果，针对相应土层埋藏条件及拟采用的基础形式，按照《岩土工程勘察文件编制深度规定》（DGJ08-72-98）要求，提供各地基土层沉降量估算岩土参数（见表 8）。具体设计时土层压缩模量可按相应压力段的 E_s 取值或从综合压缩曲线上取值计算确定。

Provide the geotechnical parameters of the foundation transformation settlement estimation on the basis of the comprehensive results from soil tests and in-situ tests of each foundation soil stratum, the corresponding foundation soil's embedment conditions and future base form, and the Code DGJ08-72-98. (See Table 8). While designing, the strata compressibility modulus can be got according to the E_s of the corresponding pressure length or the comprehensive compressibility curve.

表 8

地基变形估算岩土参数表

层号	土 层 名 称	天然重度 γ (kN/m ³)	压缩模量 E_s (MPa)				
			$E_{s0.1\sim0.2}$	$E_{s0.2\sim0.4}$	$E_{s0.4\sim0.6}$	$E_{s0.6\sim0.8}$	$E_{s0.8\sim1.2}$
① ₁	灰黄、黄灰素填土	18.0					
②	褐黄色粘土	18.8	4.33				
③	灰色淤泥质粉质粘土	17.2	2.43				
③ _夹	灰色粘质粉土	19.1	9.86				
④	灰色淤泥质粘土	17.1	2.34				
⑤ ₁	灰、褐灰色粉质粘土	18.3	3.56	3.56	5.62		
⑥	暗绿~褐黄色粉质粘土	20.0	6.10	8.98	13.66	17.07	
⑦ ₁₋₁	褐黄色砂质粉土夹粉质粘土	19.2	8.74	13.11	19.33	24.48	38.65
⑦ ₁₋₂	褐黄、草黄色砂质粉土	19.3	14.83	20.93	32.95	39.53	50.83
⑦ ₂	灰黄色粉砂	19.6	14.83	23.73	35.58	44.48	54.74

四、地基基础形式分析 IV. Analysis and evaluation of the foundation soil

(一) 天然地基 1. natural foundation

场地浅层分布的②层褐黄色粘土，其含水量 $W=33.2\%$ ，天然重度 $\gamma=18.8\text{kN/m}^3$ ，孔隙比 $e=0.950$ ，液性指数 $I_L=0.51$ ，压缩模量 $E_s=4.33\text{MPa}$ ，直剪固快 $C_k=28\text{kPa}$ ， $\phi_k=13.7^\circ$ ，静探 $P_s=0.76\text{MPa}$ ，工程力学性质尚好，在基础宽度 $b=1.5\text{m}$ ，基底砌深 $d=1.00\text{m}$ 的假定条件下，其地基承载力设计值 $f_d=110\text{kPa}$ ，可作为荷载较小的低层建筑及附属建筑的天然地基持力层。

Brown yellow clay Stratum ② exists in the shallow part. Its moisture percentage $W=33.2\%$, the natural weight $\gamma=18.8\text{kN/m}^3$, porosity $e=0.950$, liquefaction index $I_L=0.51$, compression modulus $E_s=4.33\text{MPa}$, direct shear consolidation $C_k=28\text{kPa}$, $\phi_k=13.7^\circ$, CPT $P_s=0.76\text{MPa}$. In addition, it has good mechanical features. If it is assumed that its foundation width $b=1.5\text{m}$, and its foundation depth $d=1.00\text{m}$, the foundation bearing capacity design value $f_d=110\text{kPa}$. It can be the natural sustaining bearing stratum for the low buildings and auxiliary buildings with low load.

1、辅助设施 accessory facilities

门卫、自行车库等荷载很小的建筑，一般可采用以②层土作持力层的天然地基；基础砌置标高为 2.8m 左右。对涉及暗浜分布或填土厚度较大地段，可采用换土垫层法进行处理，必要时可于明、暗浜区设置短桩进行处理。

The light-loaded buildings, including the guardroom, etc. may adopt the natural foundation with stratum ② as the sustaining stratum. The elevation of foundation bellow grade shall be about 2.8m. For the drain moles, soil replacement and cushion treatment, or short piles are adopted by necessary.

2、变电站 substation

荷载一般较小，采用以②层土作持力层的天然地基时，地基承载力一般可满足上部荷载要求，但考虑沉降控制要求较严格，宜采用沉降控制复合桩基或桩基础，一般可采用边长 250mm 的预制小方桩，桩端全断面入土深度 21.5m 可满足要求。

Substation's loading is relatively lighter, it may adopt the natural foundation with stratum ② as the sustaining stratum. The foundation's sustaining force is generally able to hold the loading. However, in order to meet settlement control requirements, settlement control complex pile foundation and pile foundation shall be adopted. Their length is required to be 250mm; the pile end section shall reach as deep as 21.5m.

(二) 桩基础 pile foundation

对于荷重较大或沉降控制较严格的拟建物，场地 24.5m 左右以浅分布的地基土主要为压缩性高、力学性质差的③、④、⑤₁层淤泥质粘性土、粉质粘土，地基压缩变形较大，不宜选择采用天然地基，宜采用桩基础。

For the heavy-loaded buildings, or the buildings that require strict settlement control, shall use pile foundation instead of natural foundation. The foundation soil 24.5 meters shallow in the site is mainly the mucky silty clay, silty clay of strata ②、③、⑤₁. It is of high compressibility and poor nature in mechanical properties. In addition, it transforms much when compressed.

1、桩基持力层的选择与分析 the choosing and analysis of the pile foundation's sustaining stratum

场地分布的地基土层中，⑥层以浅地基土基本为软弱粘性土，一般不宜作为桩基础持力层。⑥、⑦层土埋藏适中，分布较稳定，力学性质良好，为本场地良好的桩基持力层。本场地拟建物可根据各单体的具体情况，选择以⑥、⑦₁层为不同承载力需求的桩基持力层，其中⑦₁₋₁层土质不均一，以该层土作桩基持力层时，需注意单桩承载力的不稳定性。

In the foundation soil, all strata above stratum ⑥ are basically weak clay so that they are not suitable to be the sustaining strata of pile foundation. However, the embedment of Stratum ⑥、⑦ is moderate, and they have stable distribution, and good mechanical properties. Therefore, they can be the good sustaining stratum in this site. Stratum ⑥、⑦ can be the sustaining strata for the different buildings according to the different conditions of respective buildings. It must be attention to the stability of the pile bearing capacity while use the stratum ⑦₁₋₁ as sustaining stratum, because if stratum ⑦₁₋₁ is not even.

根据本场地工程地质条件及环境条件，可选择采用预制方桩、预应力管桩及钻孔灌注桩基，但从工程进度、基础投入及质量控制方面考虑，采用预制桩基方案最佳。

According to the engineering geology and environment of the site, precast piles, rounded prestressed piles and drilled cast-on-place piles may be adopted. As far as the engineering procedure, the infrastructure investment and the quality control are concerned, precast piles is the best one.

A、芯片生产厂房 **FAB**

3 层，框架结构，柱网间距 $7.2\text{m} \times 7.2\text{m}$ ，底板荷载 86.4kPa ，中柱单柱设计荷载 9390kN ，边柱设计荷载 4950kN ，必须采用桩基础。可采用边长 400mm 或 450mm ，以⑦₁₋₂层作桩基持力层，桩端全断面入土深度分别在 32m 、 34m 左右的预制方桩。

Three-storey; frame structure; the distance between columns is $7.2\text{m} \times 7.2\text{m}$; the plate load is 86.4kPa ; the middle single column's load is designed as 9390kN ; the side columns' load is 4950kN ; foundation piles must be adopted. The following piles may be adopted: precast piles of 400mm or 450mm in side length; precast piles, the end section of which reaches as deep as about 32.0m or 34.0m with stratum ⑦₁₋₂ as the sustaining strata.

B、动力站房 **CUB**

2 层，框架结构，柱网间距 $7.2\text{m} \times 7.2\text{m}$ ，中柱单柱设计荷载 6129kN ，边柱设计荷载 4080kN ，可采用边长 400mm 或 450mm ，以⑦₁₋₁或⑦₁₋₂层为桩基持力层，桩端全断面入土深度分别为 31.5m 、 34m 的预制方桩。

Two-storey; frame structure; the distance between columns is $7.2\text{m} \times 7.2\text{m}$; the middle single column's load is designed as 6129kN ; the side columns' load is 4080kN ; The precast piles of 400mm or 450mm in side length, the end section of which reaches as deep as about 31.5m and 34.0m with stratum ⑦₁₋₁ and stratum ⑦₁₋₂ as the sustaining strata may be adopted.

C、行政办公楼和工程师办公楼 **administration office buildings and engineers' office buildings**

3 层、4 层，框架结构，柱网间距 $7.2\text{m} \times 6.0\text{m}$ ，中柱单柱设计荷载 3900kN ，边柱设计荷载 2460kN ，可采用边长 400mm 的，以⑥层下部或⑦₁₋₁层作桩基持力层，桩端全断面入土深度分别在 27.5m 和 30.0m 左右的预制方桩。

Three-storey, four-storey; frame structure; the distance between columns is $7.2\text{m} \times 6.0\text{m}$; the middle single column's load is 2460kN ; The precast piles of 400mm in side length, the end section of which reaches as deep as about 27.5m and 30.0m with stratum ⑦₁₋₁ and stratum ⑥ as the sustaining strata may be adopted.

D、水箱 **water tank**

直径 $7 \sim 8\text{m}$ ，混凝土结构，结构总高度 11m ，采用半埋式，地下埋深 5.5m ，考虑基础开挖补偿作用及地下水浮力，基底压力不大，天然地基承载力可满足上部荷载要求，但为控制建筑沉降，宜设置桩基，一般采用边长 350mm 的预制方桩，以⑥层中下部作桩基持力层，桩端全断面入土深度 27.5m 左右可满足要求。

$7 \sim 8\text{m}$ in diameter; concrete construction; 11m in height; half-buried, with 5.5m under the ground. As far as the compensation function while dredging the base, and the underground water's flotation are concerned, the natural foundation's sustaining force can bear the above load as the base

pressure is fairly small. But the pile foundation should be used for controlling the settlement of the above construct. Generally the precast piles of 350mm in side length, the end section of which reaches as deep as about 27.5m with stratum ⑥ as the sustaining strata may be adopted.

E、气站 gas plant

大部分处于河浜中，需采用桩基础。可采用边长 350mm或 400mm，分别以⑥层下部或⑦₁₋₁层作桩基持力层，桩端全断面入土深度分别在 27.5m和 30.0m左右的预制方桩。

As the most part is on the ponds, foundation piles are need. The precast piles shall be 350mm or 400mm in side length, with the below part of stratum ⑥ or ⑦₁₋₁ as the sustaining stratum. The end section reaches as deep as about 27.5m or 30.0m.

2. 单桩竖向承载力估算 the estimation of vertical bearing force of the single pile

根据表 7 提供的桩基承载力参数，对以⑥层、⑦₁层为持力层的单桩竖向承载力进行估算（估算结果见表 9）。

According to the pile foundation's bearing capacity parameters in Table 7, the vertical bearing capacity of the single pile, the sustaining strata of which are stratum ⑥ or ⑦₁₋₁, (Refer to Table 9 for estimation results) can be calculated:

3. 基坑设计初步分析 the elementary analysis of the foundation pit designing

本工程水箱基坑开挖深度约 5.5m，属三级基坑，基坑开挖深度以浅涉及的土层主要有①、②、③、③_夹层，以粘性土、淤泥质土为主，渗透性能相对较小，但局部涉及渗透性能相对较好的③层中的粉土薄夹层或③_夹层粘质粉土。为维护开挖基坑的稳定性及防止③_夹层粘质粉土和③层土中所夹的粉土薄层的流砂现象，应采取必要的降、排水措施及围护措施，以避免流

表 9 单桩竖向承载力估算表

房号	桩型	桩径 (mm)	估算 孔号	桩端所处 土层编 号	桩端全断面 入土 深度(m)	送 桩 (m)	有 效 桩 长 (m)	桩侧极限总摩 阻力标准值 R _{sk} (kN)	桩端极限阻力 标准值R _{pk} (kN)	单桩竖向极限 承载力标准值 R _k (kN)	单桩竖向承载 力设计值R _d (kN)
主厂 房	预制桩	400×400	J20	⑦ ₁₋₂	32.0	2.5	29.5	1850	800	2650	1656
		450×450		⑦ ₁₋₂	34.0	2.5	31.5	2423	1012	3436	2147
	PHC 桩	φ 400		⑦ ₁₋₂	32.0	2.5	29.5	1453	628	2081	1301
动力 站房	预制桩	400×400	J10	⑦ ₁₋₂	31.5	2.5	29.0	1752	800	2552	1595
		400×400		⑦ ₁₋₂	34.0	2.5	31.5	2398	1012	3411	2131
	PHC 桩	φ 400		⑦ ₁₋₂	31.5	2.5	29.0	1376	628	2004	1252
办公 楼	预制桩	400×400	J30	⑥	28.0	2.5	25.5	1268	400	1668	1042
		400×400		⑦ ₁₋₁	30.0	2.5	27.5	1605	480	2085	1303
水塔	预制桩	350×350	J45	⑥	27.5	2.5	22.0	875	306	1182	738
气站	预制桩	350×350	J8	⑥	27.5	2.5	25.0	1042	306	1348	842
		400×400		⑦ ₁₋₁	30.0	2.5	27.5	1527	480	2007	1254

注： 1. 当按地基土计算单桩竖向承载力设计值超过桩身强度时，则单桩竖向承载力设计值应按桩身强度取值；
2. 桩端全断面不包括桩尖部分，即有效桩长不包括桩尖部分；
3. 单桩承载力计算时，不计填土层侧摩阻力。

砂、管涌等不良地质现象的发生。可采用水泥搅拌桩进行围护开挖，并设置井点降水。为满足基坑设计需要，提供设计所需的岩土参数，见表 10。

The foundation pit of the water tank engineering is of 5.5m in depth, and of three-class. the strata involved in pit dredging are stratum ①、②、③、③_夹. They are mainly composed of clay and slush with slight permeability. However, there exist some stratum ③ silt layers and stratum ③_夹 clayey silt that have good permeability in some parts. In order to maintain the stability of the foundation pit, and to prevent the quick sand phenomenon If the stratum ③ silt layers and stratum ③_夹 clayey silt, and other unfavorable geological conditions, such as piping, necessary measurements shall be taken, such as draining, enclosure, etc. Concrete churning piles, with the well dewatering method can be used in enclosure dredging. To meet the foundation pit designing requirements, the geological parameters are listed in Table 10.

表 10 基坑围护、设计所需岩土参数表

层号	土层名称	直剪固快峰值强度		无侧限抗压强度			渗透系数(cm/s)		不均匀系数
		C _k (kPa)	Φ _k (°)	q _u (kPa)	q _u ' (kPa)	s _t	水平向 K _h	垂直向 K _v	d ₆₀ /d ₁₀
②	褐黄色粘土	28	13.7	111.3	71.0	1.57	1.98E-7	1.50E-7	
③	灰色淤泥质粉质粘土	15	9.8	34.9	16.4	2.13	2.34E-7	2.28E-7	
③ _夹	灰色粘质粉土	15	24.5				1.15E-5	9.16E-6	4.84
④	灰色淤泥质粘土	17	9.2	44.9	20.0	2.25	2.24E-7	1.50E-7	
⑤	灰、褐灰色粉质粘土	21	13.9	110.0	46.1	2.39	1.54E-7	8.90E-8	

五、沉桩可能性及沉桩对周围环境的影响

1、沉桩可能性 Feasibility of pile sinking

张江高科技园区内大量工程实践证明，本工程采用边长 400mm 或 450mm 预制桩按目前桩基施工能力，只要选择合理的贯入力，上述各桩型沉桩均可顺利实现。

Many projects in Zhangjiang Hi-tech Zone show that: given the pile foundation construction capacity of the present time, if precast piles of 400mm or 450mm are adopted, pile sinking can be smoothly done provided the proper pile driving force. However, the displacement pile foundation is restricted due to the environment conditions.

建议进行试沉桩判定沉桩可行性和确定施工参数，通过单桩静载荷试验确定单桩竖向承载力，桩基试桩间歇时间应在单栋建筑桩基施工全部完成后 28 天以上。

Trial piles are suggested to certify construction possibility and construction parameters. Plate loading tests can be made to find the vertical bearing capacity of single pile. The interval of trial pile sinking should be more than 28 days after foundation construction of one building is finished.

2、桩基施工对周围环境的影响 Analysis of foundation construction effects on environment

本场地空阔，且每个承台下桩数较少，桩基施工所产生的挤土效应不很强烈，施工时只须合理安排施工流程，控制沉桩速率，并做好必要的监测工作，沉桩对周围环境的影响较小。

This site is open, and there are few piles under each platform, thus the displacement effects from the foundation construction are not strong. As long as a reasonable construction procedures is made, pile sinking speed is controlled, and necessary monitor work is done, pile sinking would leave little effect on the environment.

第四节 结论与建议

Four conclusion and suggestions

一、结论 I .Conclusion

1、将场地内埋深 50.77m 以浅土层可划分为 10 个层次、1 个透镜体，地基土构成与特征见表 3 与工程地质剖面图；各土层物理力学性质综合指标见表 4；地基土特性参数见表 5、表 6；地基承载力设计值及桩基承载力参数值见表 7。

We divided the subsoil disclosed within 50.77 on site into 10 strata and 1 lentoid. Components and features of the foundation soil are shown in Table 3 and the Engineering Geological Section Plane. The comprehensive mechanical properties of each stratum are provided in Table 4. The parameters of foundation soil bearing capacity and pile foundation bearing capacity are listed in Table 5 and Table 6. Refer to Table 7 for the foundation bearing capacity design value and pile foundation bearing capacity parameters.

2、勘察期间，场地浅部地下水水位为 3.0m 左右（吴淞高程），常年平均地下水位埋深可取 0.5m。经判定场地浅部地下水对砼无腐蚀性。

During the exploration, the average embedment of the underground water is 3.0m (Wusong altitude). The usual embedment of the underground water level is 0.5m. The site's shallow underground water is not corrosive to concrete.

3、场地内明、暗浜发育，除动力站房、变电站及一期水塔、油罐不涉及暗浜外，其余拟建物都不同程度地涉及明、暗浜。总体走向呈东西向与南北向，宽 6~18m，深 2.6~3.6m，明浜淤泥厚度 1.0~1.8m，场地东侧拟建主厂房及二期动力站房分布有暗浜，暗浜宽 6.0~18.0m，深 2.6~3.6m。暗浜充填物主厂房部分以粘性土为主，含大量黑色有机质；二期动力站房部分为新近建筑垃圾充填，含大量碎砖石，成分杂，力学性质均极差，不能直接作拟建物的基础持力层。

There exist both plane and dark ponds in the site. Except power station, transformer substation, first-phase water tower, oil tank, the other buildings are on the dark ponds more or less. Generally, the rivers tend to flow from east to west, and from south to north. They are 6~18m in width, and 2.6~3.6m in depth. The muck depth of plane rivers are 1.0~1.8m. To the west of the site, there is a dark pond around the proposed production hall and the second-phase power station, which is 6~18m in width, and 2.6~3.6m in depth. The pond refill is mainly clay with large contents of black organic matters in the main production hall and new construction garbage with many broken bricks in the second-phase power station. They are of poor mechanical properties and can not serve as the foundation-sustaining layer for the proposed buildings.

本次施工的勘探孔未遇地下障碍物。

No underground obstacles are met during this construction investigation.

4、拟建场地建筑场地类别为IV类，地震基本烈度为 7 度。场地埋深 15m 以浅地基土在地震烈度 7 度条件下，不会发生砂土液化。

It is judged that the site is IV class. Its seismic intensity is 7 degrees. There would be no sandy liquefaction under the condition of 7 degrees seismic intensity.

5、场地埋深 10m 以浅土壤电阻率由浅到深呈逐渐变小的趋势。

For the soil above 10m, the soil resistivity tends to become weaker in accordance with the depth of the soil.

二、建议 II. Suggestions

1、对于荷载较小、沉降控制要求一般的一般性建筑、附属设施，可选择以②层土为天然地基持力层，基底砌置标高为 2.8m 左右，局部涉及暗浜或填土厚度较大的地区，可采用换土垫层进行处理，必要时，可于暗浜区采用短桩处理。

Stratum ② can act as the natural foundation's sustaining stratum for the light-loaded low buildings and accessory buildings. The elevation of foundation bottom face shall be about 2.8m. For the drain moles, soil replacement and cushion treatment, or shout piles are adopted by necessary.

2、芯片生产厂房采用边长 400mm，以⑦₁₋₂层作桩基持力层，桩端全断面入土深度在 32.0m 左右的预制方桩。

The precast piles may be adopted for the FAB: precast piles of 400mm in side length; the end section of which reaches as deep as 32.0m with stratum ⑦₁₋₂ as the sustaining strata.

3、动力站房可采用边长 400mm，以⑦₁₋₂层为桩基持力层，桩端全断面入土深度 31.5m 左右的预制方桩。

The precast piles of 400mm in side length, the end section of which reaches as deep as 31.5m with stratum ⑦₁₋₂ as the sustaining strata, may be adopted for the CUB.

4、行政办公楼和工程师办公楼采用边长 400mm，以⑥层下部为桩基持力层，桩端全断面入土深度 27.5m 左右的预制方桩。

For the administration office buildings and engineers' office buildings, the precast piles of 400mm in side length, the end section of which reaches as deep as 27.5m with the lower part of stratum ⑥ as the sustaining strata, may be adopted.

5、水箱为控制建筑沉降，采用边长 350mm 的预制方桩，以⑥层中下部作桩基持力层，桩端全断面入土深度为 27.5m 左右。基坑采用水泥搅拌桩进行围护开挖，并设置井点降水。

Pile foundation shall be used to control the water tank's settlement. Usually, the precast pile of 350mm in side length, the end section of which reaches as deep as 27.5m with lower part of stratum ⑥ as the sustaining strata, may be adopted. In order to prevent unfavorable geological conditions, concrete churning piles shall be taken, with the well dewatering method can be used in enclosure dredging.

6、气站选择⑥层下部为桩基持力层，桩边长 350mm，桩端全断面入土深度 27.5m 左右的预制方桩。

For the gas plant, the precast piles shall be 350mm in side length, with the below part of stratum ⑥ as the sustaining stratum. The end section reaches as deep as 27.5m.

7、做好地基验槽和桩基检测工作，通过单桩静载荷试验确定单桩承载力，基桩静载荷试验间歇时间应在单栋建筑沉桩全部结束后起算 28 天以上。

The interval of the pile's static load test shall span over 28 days after the end of the pile sinking of one single building.