Chapter 1 Method Statement of PVD Installation

1 Scope of Work

Duyen Hai 2 Thermal Power Plant Project is located at Duyen Hai, Tra Vinh Province. The plant site is located the two branch estuaries of the Mekong River; the area belongs to the typical delta landform formed by interaction of the land and the sea, of the feature of alluvial flat area at the edge of wash plain. It is about 250km from the project site to the Ho Chi Minh City by No.1 national highway of Vietnam. The project scale is a 2 × 622MW coal-fired power plant.

This work comprises the installation of prefabricated vertical drains (PVD) in accordance to related specifications, drawings and contract documents and be directed by the Engineer.

As per design documents, the whole construction field is to be geo-technically improved by preloading method. Therefore, PVDs are required to be installed as the drainage paths throughout the construction field . The scope of installation of PVD includes the following works:

1) Setting out and measuring the existing ground level.
2) ~~Geological exploration to determine the level of draining layer.~~
3) Installation of PVD.

2 Reference

1) Design Report of Soil Improvement (50-F06991C-T0201)
2) Geotechnical Investigation Report (50-F06991C-G0101)
3) Technical Code for Ground Treatment of Buildings (JGJ79—2012)
4) Code for Acceptance of Construction Quality of Building Foundation (GB50202—2002)

3 Description of Techniques

PVD function as vertical draining paths facilitating the draining out of underground water within the soft soils, and are to be installed at positions set out previously at 1m × 1m spacing by installation rigs.

For vacuum preloading areas and vacuum surcharge combined areas(Zone A, B and C), PVDs have to be more than 0.9m above the sand blanket in order to connect themselves with filter pipes. to

Chapter 2 Method Statement of Sealing Wall

1 Scope of Works

The works of sealing wall is adapted to all the boundary of vacuum preloading area and vacuum surcharge combined areas including Zone A1, A2, A3, A4, B1, B2,C1, C2, C3, C4,C5,C6.

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2 Reference

1) Design Report of Soil Improvement (50-F06991C-T0201)
2) Geotechnical Investigation Report (50-F06991C-G0101)
3) Technical Code for Ground Treatment of Buildings (JGJ79—2012)
4) The related specifications and documents approved by the owner that can be used in this project.

3 Technical Description

The geologic investigation report shows that the site is backfilled about 3m fine sand and one intermediate layer (2a layer). As for vacuum method, sand layer is dangerous from keep a high vacuum pressure. As a result, the vacuum preloading area must be cut off with sealing wall to achieve good sealing effect surrounding the whole vacuum area.

The equipment used is similar to the double-shaft cement mixing pile. And the difference lies in the grouting material—clay replacing cement.

According to many construction experiences, the average specific gravity of slurry for sealing wall is not less than 1.3, and the slurry can be made of any kind of clay material on site. In according to experience in many projects in China,Vietnam and other countries.Mud is often used as clay material .Mud will be carried in a vehicle to site. Specific gravity of slurry for sealing wall shall be not less than 1.3 as quality control at site for preferable to sealing effect.Four-jetting and four-mixing (jetting for two settlements and two uplifts—four processes) shall be made during installing sealing wall. These can make sure the vacuum pressure is not less than 80kPa.

Mud pit shall be dug near the construction site for mud storage and mixing.

The sealing wall shall be formed of two rows of piles, with 700mm in pile diameter, overlapping 200mm in horizontal/longitudinal directions.

Zone	Sub-Zone Item	Quantity (m)	Efficiency (m/per shift)	Rigs Quantity Arrangement	Duration (Day)
Zone A	Sub-Zone A1/A2 Sealing Wall	1126.3	5	11	19
	Sub-Zone A3/A4 Sealing Wall	516.8	5	6	16
Zone B	Sub-Zone B1 Sealing Wall	521.3	5	11	8
	Sub-Zone B2 Sealing Wall	322.4	5	5	12
Zone C	Sub-Zone C1 Sealing Wall	579.2	5	6	18
	Sub-Zone C2 Sealing Wall	613.3	5	5	24
	Sub-Zone C3 Sealing Wall	420	5	6	14
	Sub-Zone C4 Sealing Wall	350	5	5	14

Table.2 The equipment arrangement and construction schedule for sealing wall

6 Quality Control

Construction process must be in accordance with the construction drawings and design documents, such as the case of design drawings, documents do not match with the actual situation, should be immediately reported to supervision or to amend the contractor, to be made based on the file and then continue with the work.

Construction process to strengthen the interface between the work procedures, hidden project supervision engineers, and others should be reported to check, submit a complete self-test data reported to supervising engineers for review, qualified only after signing processes the next construction.

Establish viable quality management rules and regulations. Strictly to good quality, the quality questions of the construction occurred during the accident, the cause of the accident should be carefully analyzed, drawing lessons and harshly punish those responsible, and report project manager and chief engineer, to make appropriate treatment measures.

4	Tension strength at break (MD)	KN/m	≥8.0	
5	Elongation at break	%	25~100	
6	CBR puncture strength	KN	≥1.2	
7	Equivalent aperture O_{90}	mm	0.07~0.20	
8	Vertical permeability coefficient	cm/s	5×(10-2~10-1)	
9	Trapezoidal tear strength	kN	≥0.20	

Fig.2 Non-woven geo-textile

3.1.4 Geo-membrane

Geo-membrane is made of polyvinyl chloride, black and flexible with thickness 0.14mm. Geo-membrane shall be spread and cover the whole area proposed to use vacuum preloading method.

In order to maintain a steady high negative pressure (80kPa) in soil, geo-membrane has following characteristics:

- ✓ Impervious to air and water even in a pressure more than 80kPa.
- ✓ Has enough tension strength to adapt to surface deformation.

The technical specifications are shown in table 4. and the construction photo are shown in Fig.3.

Table.4 Specification of geo-membrane

Tensile strength (MPa)		Elongation at break (%)	Right angle rupture strength (kN/m)	Thickness (mm)
Longitudinal	Transverse			
≥18.5	≥16.5	>220	≥40	0.12~0.16

2. The power supply must be ensured during vacuum running. Although it is available to connect the site with the power grid, some generators may be provided at the site, which can ensure 1/2 design vacuum pumps in normal running in case of outage and maintain some vacuum pressure in the whole zone because the drop of vacuum pressure due to outage will affect the treatment effect of foundation.

3. Since the vacuum preloading time is very long and the damages or scrapings of vacuum pump are inevitable, some vacuum pumps shall be reserved at the site to replace the damaged ones while not affecting construction quality and schedule. The spare vacuum pumps are about 10% of design quantity in each zone.

4. The 7^{th}~10^{th} day following vacuum preloading is the system commissioning period when the vacuum pressure will drop gradually below -80kPa. Accordingly, the geo-membrane shall be also subject to tightness inspection and the leakage in the geo-membrane part can be found during this period. Special personnel shall make daily inspection to the geo-membrane such as visual check and listening etc and make timely repair for the problems found. After the system is confirmed normal and the associated conditions are met, it can be loaded.

5. During vacuum preloading period, the surface settlement, void water pressure and sub-layer settlement etc shall be subject to monitoring so as to achieve good appraisal on the foundation treatment effect and quality control over the process. Based on these monitoring data, necessary reverse analysis shall be made to finally determine the final settlement and degree of consolidation etc.

6. Based on the results of reverse analysis, associated measures can be taken to ensure the construction quality and schedule.

5.7 Surcharge combined

According to design report, Zone A is vacuum preloading area, 30cm sand shall be backfilled above the geo-textile as the protection layer, the sand filling can be finished in one time. Except Zone A, Zone B and C are vacuum surcharge combined preloading method. Of them, Zone B shall be 2m surcharge load and Zone C shall be 5.5m surcharge load. Considering the sand surcharge is enough thickness, multi-stage loading is needed. According to design report, per stage of surcharge loading shall be controlled within 0.5m with mechanical compaction. Since mechanical compaction is easy to break geo-membrane, this task shall be conducted by road roller or full hammer compaction according to sand conditions after vacuum preloading.The compaction density is required not less than 90%.

3.1.2. Horizontal drain PVD and plastic blind ditch

Horizontal drain PVD shall be same with vertical PVD used in PVD installation, the specification refer to Method Statement of PVD Installation. The horizontal drain PVD shall connect with plastic blind ditch in 20m. The specification of plastic blind ditch is shown in Table.1.

Table.1The specification of plastic blind ditch

No.	Specification Item		Unit	Qualified Result	Reference
1	Appearance Diameter		mm	200	Q/320282SNW003-2015
2	Inner Diameter		mm	150	
3	Weight		g/m	2000	
4	Porosity		%	80	
5	Compressive Strength	Flattening 5%	kPa	10	
		Flattening 10%	kPa	25	
		Flattening 20%	kPa	30	
		Flattening 30%	kPa	50	

3.1.3 Drainage Well

The drainage well shall layout alone plastic blind ditch with 20m per piece .It is consist of steel frame and geo-textile wrapped outside. The fabrication of drainage wells shall be finished in the site while the steel frame is welded in the site and wrapped geo-textile is achieved by sewing machine in the site. The steel compliance with VN codes shall be purchased and fabricated and the geo-textile is required with vertical permeability coefficient not less than 9×10-2cm/s. It's function is as follow:

a. Surcharge loading make pore water spilling throughout vertical PVD. The pore water shall be collected in the drainage wells.
b. The pumping system have the pipe reaching the bottom of drainage wells and pumping water out. In case of this, the water level inside drainage wells always can be controlled lower than nearby surcharge area so that the pore water shall be pumped away continuously.

The consist of drainage and specification is as Fig.1

5 Analysis of Consolidation Degree

Degree of consolidation (DOC) can be assessed using the rate of settlement or pore pressure data which could be computed from the monitoring data.

Because the performance criteria are extremely severe, back-analysis shall be implemented to determine the moment when vacuum operation could be safely stopped. As it is not possible to rely only on the pore pressure analysis, it shall be performed design and back-analysis calculations based on a void ratio target or allowable settlement target to meet the guarantee criteria.

After finishing soil improvement work, the post-improvement settlement shall be less than 20cm within 10 years under design load.

As a consequence, the concept of void ratio or settlement target shall be introduced for each layer.

In the design stage, for each area, a settlement target has been calculated with initial soil parameters. For determination of this settlement target, a loop calculation has to be performed to compute 100% of primary settlement. Then secondary settlement is determined separately depending of the aging of the clay or secondary consolidation coefficient of clay that is calculated from consolidation test data.

In the field, two methods are commonly used for predicting the ultimate settlement using monitoring data. One is proposed by Asaoka (1978) and the other is three-point regression method.

5.1 Asaoka method

In this method, a series of settlement data S (S1, S2……Si-1, Si, Si+1,…SN) are observed at constant interval time. Then these are plotted as Sn (in vertical axis) versus Sn-1 (in horizontal axis) as shown in Fig.9. The ultimate settlement (Sult) shall be computed from Fig.10.

The degree of consolidation (DOC) is determined as follow:

$$DOC = \frac{S_t}{S_{ult}} \times 100\% \quad (1)$$

Where:

DOC – the degree of consolidation (%);

S_t – the settlement at the time when DOC is determine (m);

S_{ult} – the ultimate settlement updated to the time when DOC is determine (m);

cut off water supply from the underlain draining layer, lower ends of PVD have to be 0.5m above the top of the draining layer of which the level shall be determined by geotechnical exploration.

For surcharge preloading areas(Zone D), PVDs also have to be more than 0.9m above the sand blanket in order to connect themselves with horizontal drainage PVDs, lower ends of PVD should come into 0.5m~1m the draining layer of which the level shall be determined by geotechnical exploration.

4 Stability of Working Platform

The working platform was formed by hydraulic filling sand on original ground. The thickness of the platform is based on as-built drawings of sand filling for each zone. This layer is convenient and stable to be as the working platform of heavy PVD equipments. According to the Design Report of Soil Improvement (50-F06991C-T0201), each zone shall start PVD installation work with the requirement that the elevation reach +3.5m after sand filling, the detail techniques and procedure about sand filling refer to WPP Method Statement Backfilling Sand; Fence Protecting Fly Sand - Temporary Dike (DH2-DD09-P0ZEN-720001).

5 Material and Equipments

5.1 Materials

The PVDs are consisted of a core enclosed in a non-woven filter jacket. The jacket allows free passage of pore water to the core without loss of soil material. The filter jacket shall be capable of resisting all bending, punching and tensioning subjected during installation and the design life of the drain.

The core shall be made of continuous plastic fabricated to facilitate drainage along the axis of the drain. The prefabricated vertical drain shall be resistant against rotting, mildew, bacterial or insect action, salts, acids, alkalis, solvents or other constituents in the ground water.

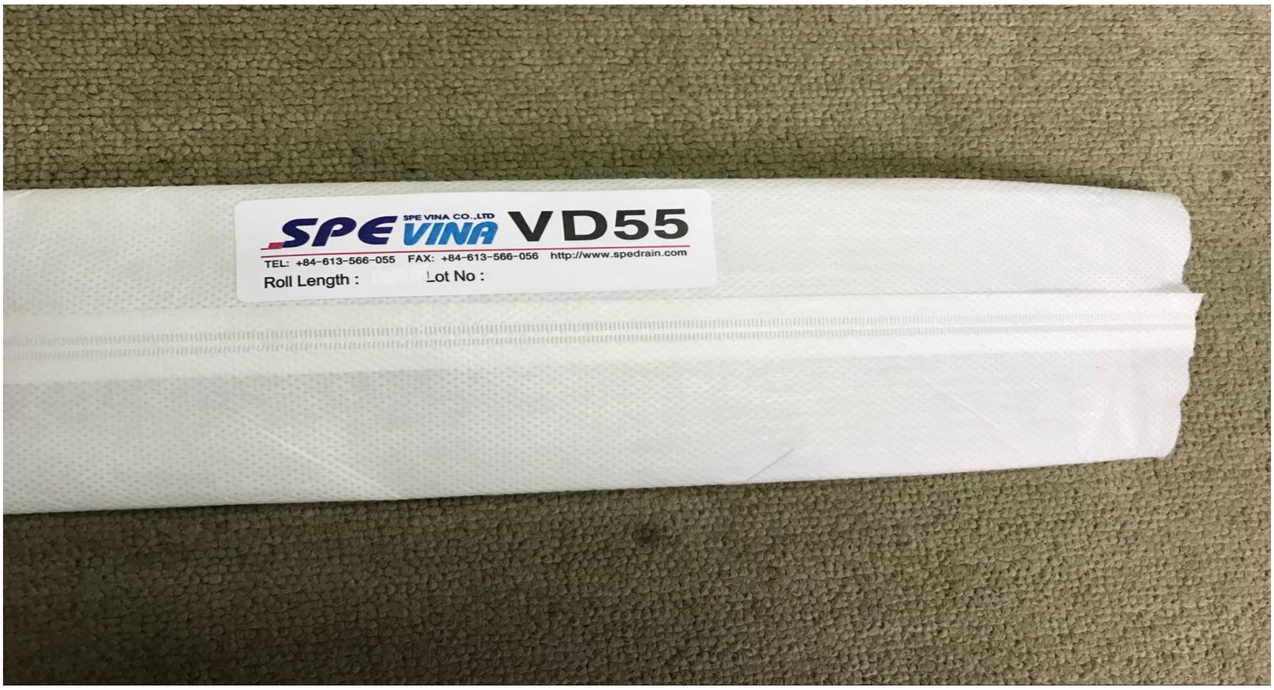
The physical and mechanical properties are given in table 1

Table 1 Capacity indices of PVD

Item		Unit	Requirement
Outline dimensions	Width	mm	100 ± 2
	Thickness	mm	≥4.5

Discharge capacity (400kPa), i=0.5		cm3/s	≥60
Permeability(dip in water 24 hours)		cm/s	≥5×10-4
Pore size O95		mm	<0.075
Strength at 10% elongation		kN/10cm	≥1.5
Filter membrane tensile strength	Dry state (at elongation of 10%)	N/cm	≥30
	Wet state (at elongation of 15%; test piece dip in water 24h)	N/cm	≥25

The sample pictures are shown in Fig. 1.



good conditions. Fig. 2 shows the PVD equipments during working.

Fig. 2 PVD installation equipment

5.3 Equipments Arrangement And Construction Schedule

The equipments' efficiency and arrangement for construction schedule shall be as Table.2.

Item	Quantity (m)	Efficiency (Per day)	Sub-Zone	Equipment Quantity	Duration（Day）
Zone A PVD Installation	2,214,270	12000m	A1、A2	8	14
			A3、A4	2	36
Zone B PVD Installation	1,534,000	12000m	B1	8	10
			B2	4	14
Zone C PVD Installation	2,653,560	12000m	C1、5	4	18
			C2、5	4	13
			C3、6	4	14
			C4、6	4	11
Zone D PVD Installation	1,315,600	12000m	2	55	Zone D PVD Installatio n

Table.2 The PVD equipment efficiency and arrangement for construction schedule