CHAPTER 2

LITERATURE REVIEW

The theoretical design of PVD installation has been discussed since the development of theoretical solution of PVD installation by Barron (1948). In this model, the model is still simple model in which the drains are considered as ideal wells, which mean their permeability could be considered as infinite. However, in practice, the well has resistance that could not be ignored that create the well resistance effect. This condition leads to first discussion about PVD modelling, whereas a simple solution to obtain average degree of consolidation (Uh) at a depth z due to drainage is then obtained (Yoshikuni & Nakanodo, 1974).

The simple solution for the PVD due to radial drainage only by Yoshikuni and Nakanodo's solution is not enough, as it is very complicated while used in practice. This is then answered by Hansbo's solution for PVD installation and is proven to be accurate to Yoshikuni and Nakanodo's solution. Hansbo develop the solution for smear zone problem that exist in Yoshikuni and Nakanodo's solution, shown in Figure 2.1. He also simplifies the diameter notation in the PVD solution, named as equivalent diameter to convert a band-shaped drain to circular cylindrical drain for simpler calculation.

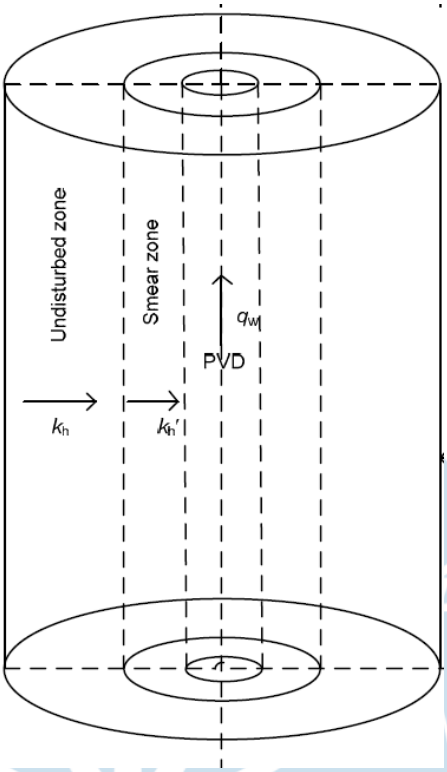

Figure 2.1 Smear Zone Effect

(Sun et al., 2020)

In theory, vertical drains increase the mass hydraulic conductivity of soil in the vertical direction. Thus, the value of hydraulic conductivity in vertical direction should be calculated, which represent both the effect of vertical drainage of natural soil and the effect of horizontal drainage due to PVD (Chai, J; Shen, 2001). The equivalent value of hydraulic conductivity proposed by Chai is then used in the development of complex function involving hydraulic conductivity in the soil in PVD modelling.

Additional complex numerical model for PVD has also been developed furthermore by various researcher (Deng et al., 2017; Parsa-Pajouh et al., 2014). Both models consider embankment as preloading for the PVD and smear zone

related effect to the model. The embankment load should also be considered in the modelling of PVD construction to consider the smearing effect caused by the smear zone during PVD construction.

In geotechnical engineering, economic design becomes highly discussed as it is desired to obtain design that follow the code as design criteria but with lowest cost possible. Wang developed the economic design of the foundation construction for geotechnical problems (Wang & Kulhawy, 2008). The model involves the usage of Particle Swarm Optimization (PSO) method, which used the variation of important dimensions, in this case length and width of the foundation, as optimization target. PSO revolves around the scatter of data looking for best possible route, named swarm to find the optimization target for lowest cost, by finding best combination of length and width of the foundation that fulfil the design criteria through iterations.

Wang's economic design also include sensitivity study of the properties, the study to determine which soil properties affect the project the most. Foundation construction always deal with many natural soil properties that could not be modified. Those properties affect the design criteria as it will affect foundation strength to resist the load, which turns to safety of the structure. However, many soil properties have many uncertainties and they are involved in designing foundation. Thus, it is required to find which of the soil properties affect the cost of the foundation the most.

In PVD modelling, Sun already created the optimization model to find lowest cost possible for the PVD construction (Sun et al., 2020). The model already considers the basic PVD modelling based on previous research, the smearing effect of the smear zone, and the embankment load that affects the PVD performance. Sun also developed cost estimation model, by formulating cost is equivalent to the ratio between length of the PVD and space of the PVD.

From Sun's model however, the sensitivity study to find which soil properties that affect PVD cost the most is still missing. Based on previous research, it is also important to determine which properties must be tested the most accurate in lab and obtain the importance to perform reliability-based design on PVD modelling.