

The Mobilized Strength of Prefabricated Vertical Drains

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ABSTRACT: This paper focuses on the mobilized strength of prefabricated vertical drains, or PVDs, and is based on the results of theoretical, laboratory and field testing on prototype PVDs. Used herein are PVD simulated units known as load-elongation measuring strips, or LEMS. Results of the paper show that the typical strength of commercially available PVDs are well in excess of the required strength when installed by properly functioning construction equipment.

KEYWORDS: Drainage, Wick Drains, Tensile Strength and Survivability

1 INTRODUCTION

PVDs have replaced conventional sand drains over the past 20 years, by providing an economical solution to rapidly consolidate fine grained saturated soils. When building on such compressible soils, large settlements are anticipated. As the soil cannot compress at a greater rate than release of the excess pore water pressure, such settlement can continue for a long period of time. PVDs are used to expedite this release of pore water hence they decrease the time for settlement and greatly facilitate the stabilization of such sites.

PVDs are approximately 100 mm wide by 2 to 5 mm thick. They are delivered on site in large rolls. Most PVDs consist of a synthetic drainage core surrounded by a nonwoven heat bonded or mechanically bonded geotextile filter. They are installed vertically in the ground by a pile driving type of construction equipment known as a "wick sticker". Spacings are typically at 1 to 5 m throughout the soil to be stabilized. The length of the drains are site specific but usually extend to the bottom of the soft soil involved.

Once the PVDs are installed over a large area, a surcharge load is placed on the ground surface to mobilize excess pore water pressure in the foundation soil. The expulsion of the water is coincident with consolidation of the soil resulting in settlement at the ground surface. Additional surcharge load is placed in incremental lifts in accordance with the design requirements. The duration of the load depends on the soil characteristics, PVD spacing and type of PVD utilized.

There is a wealth of information available on the technique and a tremendous number of PVDs have been successfully installed around the world. The design method for determining the consolidation time versus PVD spacing as well as the required flow rate has been fully described in the literature. For example, Hansbo [1979]

has developed the relationship usually used to determine the PVD spacing as a function of the desired consolidation time. Holtz, et al. [1991] has given guidance on the flow rate capacity of PVDs in the unkinked and kinked conditions.

Conversely, the mechanical strength requirements of PVDs has seen little quantitative analysis and discussion. The only reference, Kremer, et al. [1983], reports the need for a PVD tensile strength of 500 N at a corresponding minimum strain of 2%. They also suggest a maximum strain of 10%. This upper strain limit is imposed in order to avoid unwanted deformations that might compromise the drain's dimensions and thus flow capacity. The technical background for these tensile strength and strain values is not known. Thus, the pursuit of a more rigorous numerical and experimental treatment of the tensile strength requirements during installation of PVDs is the purpose of this paper.

The tensile strength of PVDs is a consideration both during installation and during consolidation. Installation challenges the drain's strength as it threads through rollers of the wick sticker. The strength of the PVD is also challenged during the mandrel withdrawal process. Both of these situations are exacerbated by high installation speeds. In addition, the tensile strength may also be an issue when the drains are collectively used to resist a circular arc failure of the weak, sensitive soil. A large number of PVDs "sewn into the ground" and working as a unit will intercept and resist such a circular arc failure. This, however, is a design issue and is not addressed in this paper.

The paper will describe theoretical, laboratory and field research aimed at determining the mobilized strength of PVDs. The paper will conclude with generic recommendations on the required strength of PVDs based on the results of this investigation.